Exploring the Nature and Acquisition of Tacit Knowledge for Military Leadership

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In this report we first introduce traditional notions of leadership and their limitations, and the importance of tacit knowledge for military leadership. We then present Sternberg's (1985, 1988, 1997) triarchic theory of intelligence and the role of practical intelligence and tacit knowledge in successful leadership. Next, we examine in-depth the nature of tacit knowledge, how it is defined and measured, how it differentiates experts from novices, and how it is bounded. Furthermore, we present a model of practical intelligence and tacit knowledge acquisition, and demonstrate how tacit knowledge may be acquired experientially and vicariously. Based on the literature reviewed, we draw hypotheses that we test empirically. We then present the results of our findings and discuss their theoretical and practical implications. Last, we relate our findings to the purpose of this report, and to the research questions we sought to answer.

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EXPLORING THE NATURE AND ACQUISITION OF TACIT KNOWLEDGE FOR
MILITARY LEADERSHIP

EXECUTIVE SUMMARY

Research Requirement:
        To determine the nature and acquisition of tacit knowledge (i.e., implicit knowledge
acquired experientially) in experienced and less-experienced US Army officers using instruments
that assess tacit knowledge and metacognitive problem-solving ability.

Procedure:
        A representative sample of Lieutenants, Captains, Majors, and Lieutenant Colonels
completed the Tacit Knowledge Inventory for Military Leaders (TKML), which measures tacit
knowledge at the platoon, company, and battalion levels. The officers also completed two
intensive case studies representing leadership scenarios at the platoon and company levels.
Statistical analyses were conducted on data generated from (a) the TKML, to determine the
relations among rank, experience, and tacit knowledge, and to determine the extent to which
tacit-knowledge scores of officers would be affected after a short, facilitated discussion; and (b)
the case studies, to determine differences between problem-solving strategies of experienced and
less-experienced officers.

Findings:
        The findings were consistent with theoretical propositions. First, higher ranking officers
demonstrated the most tacit knowledge at all levels of the TKML. Furthermore, military rank
was related to tacit-knowledge scores and officer experience (i.e., self-reported experiences
similar to those depicted in the TKML instruments). The relation of military rank to tacit
knowledge and officer experiences became more prominent at higher levels of the TKML,
because only higher ranking officers have had experience at those levels; however, all officers
have had experience at lower levels of the TKML. Second, officer experiences appeared to be
more related between adjacent levels (i.e., Lieutenants and Captains) than between nonadjacent
levels (i.e., Lieutenants and Lieutenant Colonels) of command. Third, the results of the case
studies indicated that more experienced officers could be distinguished from less experienced
officers based on their metacognitive problem-solving skills. Compared to less experienced
officers, more experienced officers were more aware of the metacognitive processes affecting
their decision making, had more tacit knowledge, and could more readily articulate that
knowledge than could less experienced officers. Last, tacit-knowledge scores remained mostly
unaffected after a facilitated group discussion.

Utilization of Findings:
        The findings indicate that the construct of tacit knowledge can be reliably measured, and
that the TKML instruments should be retained. Both our TKML and intensive case-study
instruments can distinguish more experienced—as measured by military rank—from less
experienced officers. The results pertaining to the case studies provide support for our model of
practical intelligence and tacit-knowledge acquisition. This model can be used as a foundation
for understanding and facilitating the processes underlying metacognitive problem-solving
ability. These processes include how information is acquired, how problems are framed, and how

problem-solving outcomes are monitored. Furthermore, the case-study instruments appear to have the potential to select individuals for positions that require domain-specific knowledge, and the ability to adapt to, and learn from, novel situations.

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INTRODUCTION

The Army is continuously facing challenges that were hitherto unimaginable. Downsizing, attrition, faster promotion cycles, changing technology, and objectives that go beyond the traditional realm of soldiering, make for an increasingly unstable internal and external operating environment. To cope with instability, organizations rely in part on their leadership. For the Army, developing leaders is serious business—leadership is assumed to play an instrumental role in determining organizational outcomes and troop morale, and much effort is focused on understanding and promoting leadership at all levels (U.S. Department of Army, 1999). Although some scholars dismiss the importance of leadership to organizational effectiveness as a romantic notion (Meindl & Ehrlich, 1987), most scholars agree that leadership is instrumental for organizational success (Argyris, 1976; Barnard, 1968; Bennis, 1989; Deming, 1986; Drucker, 1955; Etzioni, 1964; Schien, 1992; Senge, 1990). Vroom (1976) succinctly captured this by stating:

> There are few problems of interest to behavioral scientists with as much apparent relevance to the problems of society as the study of leadership. . . . The effective functioning of social systems . . . is assumed to be dependent on the quality of their leadership. This assumption is reflected in our tendency to blame a football coach for a losing season or to credit a general for a military victory. While one can identify many factors influencing organizational effectiveness . . . the critical importance of executive functions and of those who carry them out cannot be denied. (p. 1527)

Jacobs (1985) predicted that twenty-first century leaders at all levels of the military would need to understand systemic organizational relations and how to maneuver within them, recognize the confines of existing knowledge and adapt to unknown contexts, and experiment in new situations and learn from mistakes. Lau (1998) argued, "The effective military leader today is characterized by a high degree of flexibility, initiative, and ability to lead in complex and ambiguous circumstances" (p. 49). Thus, a key issue for the military is how to identify leadership potential, develop leadership skills, and assess leadership effectiveness at different levels of command, to ensure that the military can face the challenges of the current milieu.

Where does a leader learn to be flexible, take initiative, and lead in complex and ambiguous circumstances? Where does a leader learn the systemic nature of a complex organization, recognize the confines of existing knowledge, adapt to unknown situations, experiment, and learn from mistakes? Where do Army leaders acquire the skills necessary to face the challenges of today, tomorrow, and 20 years from now? Does an institution exist that can teach these skills? In addressing the Oxford Union in 1920, Horatio Bottomley referred to this institution as the "university of life" (Augarde, 1991).

Savvy individuals recognize that as soon as they step out of college, the academic skills they acquired may no longer be applicable or work as they should in practice. As Walt Ulmer (1999), former Lieutenant General of the U.S. Army and former director of the Center for Creative Leadership noted, "Most adult learning takes place on the job, not in the classroom" (p. 65). For that to occur, organizations must harness the capacity of individuals to learn on the job. Sternberg et al. (2000) characterized individuals with savoir-faire—graduates of the "university

of life"—as having practical intelligence. This dimension of intelligence differs from conventional notions of intelligence in that it seeks to elucidate the expertise individuals acquire from experience, and how they use this experience to pursue personally-relevant goals. Practical intelligence has very little relation to the academic intelligence cultivated in formal education and training settings. Sternberg (1998) argued that practical intelligence—as a form of expertise—can be viewed as an ability that develops with time as individuals build their repositories of knowledge and skills that are required to master a specific domain. This position is contrary to traditional notions, which view intelligence as a relatively stable trait. Practical intelligence can be conceived as a form of common sense or street smarts, and represents the ability to solve practical problems by utilizing knowledge gained from experience, and applying that knowledge to environmental adaptation. This knowledge often is held tacitly; it is an intuitive type of knowledge that is implicit, difficult to articulate, but easily drawn-on when applied to solving practical problems. We refer to this element of practical intelligence as *tacit knowledge*.

As a result of the implicit nature of tacit knowledge, one would expect it to be a slippery concept that escapes measurement; however, Wagner and Sternberg (1985) argued the contrary. As documented by Wagner and Sternberg (1990, 1991), tacit knowledge can be measured— albeit indirectly—in the domain of management. Hedlund et al. (1998), and Sternberg et al. (2000), demonstrated that tacit knowledge also applies to the military, and can be reliably measured at the platoon, company, and battalion levels. Wagner and Sternberg stated that tacit knowledge is measured by presenting individuals with problems that are rooted in practice, and that require individuals to draw on their procedural knowledge. These problems reflect situations that domain experts identified to contain knowledge that is mostly acquired experientially, is not explicated in books or policy manuals, and is not gained in formal training or schooling. Measuring the degree to which an individual has acquired tacit knowledge entails that the individual rate response options concerning those practical problems. The degree to which individuals agree with how experts rate these options, is the degree to which individuals have acquired tacit knowledge. As we will demonstrate in this report from the literature reviewed and our data, there is much evidence to suggest that tacit knowledge exists, and that it is measurable. As a construct, tacit knowledge appears to be unrelated to personality and general cognitive ability measures, and explains variation in outcomes above and beyond those measures. Furthermore, tacit knowledge appears to be an important foundation for leadership effectiveness, and our tacit-knowledge instruments differentiate more experienced from less experienced leaders in terms of their practical problem-solving knowledge and abilities.

Purpose of the Report

Because tacit knowledge is acquired experientially and with little environmental support, the onus of knowledge acquisition rests with the individual. Thus, it is highly likely that some individuals will learn successfully from their experiences while others will not. Therefore, it is critical to understand the differences between individuals with a high degree of tacit knowledge, as compared with those with a low degree of tacit knowledge, and whether tacit knowledge is related to leader effectiveness. The issue of tacit knowledge and leadership effectiveness has been dealt with elsewhere, and is beyond the scope of this report (see Hedlund et al., 1998; Sternberg et al., 2000). Rather, in this report, we will focus on the nature of tacit knowledge and its acquisition. By understanding what individuals know, how they go about solving problems,

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what information they attend to, and how these processes differ between more experienced and less experienced officers, we can begin to construct a general understanding of how to facilitate the acquisition of tacit knowledge.

The current study is an update and extension of Hedlund, Sternberg, and Psotka (2001), who reported on the processes associated with tacit-knowledge acquisition, and who described preliminary findings on the nature of tacit knowledge in military leadership. The purpose of this current study is to investigate the nature of tacit knowledge for military leadership, how it might be acquired, and the cognitive processes that underlie this acquisition process. To this end, we sought answers to the following questions: Do rank and experience affect tacit knowledge scores? Are metacognitive processes (i.e., problem identification, solution generation, outcome monitoring) identifiable? Are metacognitive processes associated with tacit knowledge? Are there differences in tacit knowledge scores and metacognitive processes when comparing more experienced with less experienced officers? Can individuals acquire tacit knowledge vicariously?

The focus of our tacit-knowledge research effort is at the individual level of analysis. Others have argued that such knowledge could reside in systems and cultures, at the group and organization level. For instance, Hill and Jones (1995) referred to the intangible nature of knowledge that allows an organization to gain a competitive advantage as being a distinctive competency that is difficult to emulate, and a substantial entry barrier to that industry for other organizations. The literature also demonstrates that tacit knowledge per se can fuse into group or organizational systems, and that tacit knowledge is critical for the creation of a competitive advantage that is not easily emulated (Baumard, 2001; Lubit, 2001; Von Krogh, Ichijo, & Nonaka, 2000). We are pleased that scholars are taking note of the importance of tacit knowledge for organizational success, and that interest in this field continues to grow. Until such point where basic theory in this area strengthens, we continue to focus our research on understanding tacit knowledge at the individual level.

In this report we first introduce traditional notions of leadership and their limitations, and the importance of tacit knowledge for military leadership. We then present Sternberg's (1985, 1988, 1997) triarchic theory of intelligence, and the role of practical intelligence and tacit knowledge in successful leadership. Next, we examine in-depth the nature of tacit knowledge, how it is defined and measured, how it differentiates experts from novices, and how it is bounded. Furthermore, we present a model of practical intelligence and tacit-knowledge acquisition, and demonstrate how tacit knowledge may be acquired experientially and vicariously. Based on the literature reviewed, we draw hypotheses that we test empirically. We then present the results of our findings and discuss their theoretical and practical implications. Last, we relate our findings to the purpose of this report, and to the research questions we sought to answer.

BACKGROUND TO THE REPORT

Based on Neisser's (1976) typology of academic versus practical intelligence, Sternberg (1985, 1997), Wagner (1987), and Wagner and Sternberg (1985, 1986) stated that different abilities are required to solve practical and academic problems. Practical problems tend to be ill

defined, contextualized, rooted in the real world, and to have a variety of solutions, while academic problems are typically well defined, not relevant to practice, and are characterized as having a correct solution. In fact, practical and academic intelligence are generally uncorrelated, and practical intelligence is at least as good a predictor of job performance as is academic intelligence (Sternberg, Wagner, Williams, & Horvath, 1995; Wagner & Sternberg, 1990). Thus, the way we define and characterize intelligent behavior and the decision-making processes associated with practical and academic tasks must take these differences into account.

The decision-making processes that apply to practical tasks have also been referred to as naturalistic decision making. This type of decision making refers to the cognitive processes of humans in dynamic and practical situations (Klein, Orasanu, Calderwood, & Zsambok, 1995). Schön (1983) noted that problems in the real world are "puzzling, troubling, and uncertain" (p. 40). The challenges faced when dealing with such problems are further confounded when managing systems that are human-intensive, because humans themselves are very complex, unstandardized and unique, and ill fitted to uniform control processes. Using a similar analogy as it applies to the military, and comparing the difference between technology versus human-intensive tasks, McGee, Jacobs, Kilcullan, and Barber (1990) noted:

> Many if not most leadership tasks are human-ascendant. They are unstructured to some extent, lack an immediately executable invariant procedure, and demand perception of an end-state that represents problem solution. Leadership tasks thus are qualitatively different from the tasks in technology-dominated systems. The latter tend to be linear, sequential, and precise by nature—depending on specific knowledge of procedure for successful operation. The former are multi-path, recursive, and fuzzy—depending on knowledge of principles and their applications for successful operation. (pp. 223-224)

Although the military—and indeed civilian organizations—are increasingly technology-driven, they still require humans to operate that technology, and to make strategic and tactical decisions while interacting with other humans. Thus, the ability of individuals to deal with the complexity and novelty associated with the management of human behavior is critical, and a function of their ability to adapt and learn. Although a plethora of leadership theories exist that ostensibly provide an explanation of effective leadership, and the types of behaviors that are associated with effective outcomes, most of these leadership theories fail to explain what leaders know that makes them effective. For example, General Walt Ulmer (1999) noted the following:

> Lieutenants will not become captains and company commanders unless they demonstrate certain proficiencies and aptitudes [including mental agility]. The lieutenant . . . carries his background of prior indoctrination into the culture and watches the people around him. He searches for clues that will link theory to reality. The busy world of daily action provides a rich source of data if he can interpret the signals. . . . He senses when to make jokes with soldiers and when not to; when to give a little slack and when to be unyielding; when to stand right on top of the action and when to leave people alone. . . . Street smarts alone can take a lieutenant a long way. (p. 66)

In the above example, why does the lieutenant choose to act in a certain way depending on the context? Why does the lieutenant choose a particular leadership style over another? What is the link between the cues provided by the environment to the behavioral strategies and

decision-making outcomes of the Lieutenant? What does the Lieutenant *know* that allows him to behave intelligently? To attempt to answer these questions we review existing leadership approaches and note their limitations, and then introduce the triarchic theory of intelligence as it applies to leadership and tacit knowledge.

Definitions of Leadership.

Organizations require leadership in order to adapt to their environments and maintain the stability of their system (Argyris, 1964; Katz & Khan, 1978). Thus, leaders must understand the system on which they are operating, and how best to integrate its discrete functions to ensure coherence in actions as they are targeted toward strategic objectives (Katz & Khan, 1978; Senge, 1990; Weisbord, 1978). As a concept, leadership has been viewed from many perspectives. Indeed, Fiedler (1971) noted, "There are almost as many definitions of leadership as there are leadership theories—and there are almost as many theories of leadership as there are psychologists working in the field" (p. 1). However, there is a general consensus that leadership involves an influencing process that is directed to achieving certain objectives (Bass, 1990; Yukl, 1998).

Leadership is often confused with management; however, many theorists view leadership and management as distinct processes (Bennis, 1989; Kotter, 1988; Zaleznik, 1989). According to Zaleznik (1989), managers and leaders differ in dispositional traits and values. Managers strive largely to maintain the status quo, focus on tasks and processes, and rely on economic exchanges to influence follower behavior. Leaders, though, focus on creating the future, often shun the status quo, are driven by vision and values, and rely on affective and symbolic means to influence behavior. Other theorists, however, view leadership as part of the management function (e.g., Koontz & Weihrich, 1988; Mintzberg, 1975). We support the position that leadership and management are independent but complementary processes; both are required for organizational success (Bass, 1985, 1990; Drucker, 1955; Yukl, 1989). We will revisit this distinction below after reviewing Sternberg's (1985, 1988, 1997) triarchic theory, and the ways in which leadership and management relate to intelligent behavior.

Leadership was originally described from a trait perspective. Although trait-based research was somewhat contradictory, results indicated that certain traits, including intelligence, have been found to be consistently associated with leadership outcomes (e.g., House & Aditya 1997; Lord, De Vader & Alliger, 1986; Spangler, House & Palrecha, 2001; Zaccaro, Foti, & Kenny, 1991). Given the early mixed reviews on trait research (e.g., Stogdill, 1948), interest then focused on the behavioral elements of leadership (e.g., Katz, Maccoby, Gurin, & Floor, 1951; Stogdill & Coons, 1957). However, these approaches also led to inconsistencies, which the contingency movement attempted to address (Fiedler, 1967; Hersey, 1975; House, 1971). After House (1977) proposed a psychological explanation of the charismatic leader, research thereafter shifted to understanding the emotional impact of leaders on followers.

Contrary to the above approaches, in this study we demonstrate the importance of cognitive perspectives for studying leadership. Although links between cognition and leadership effectiveness have been made previously by others (e.g., Argyris, 1976, 1993, 1994; Argyris, Putnam, & Smith, 1985; Zaccaro et al., 1991; Schön, 1983), these approaches were dwarfed by what Bryman (1992) characterized as the "new leadership," which focused on the charismatic

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and transformational effects of leaders on followers. Much evidence has been amassed to support the notion that leaders who exhibit charismatic or transformational behaviors are more successful than those who do not (e.g., Avolio, Howell, & Sosik, 1999; Barling, Weber, & Kelloway, 1996; Howell & Avolio, 1993; Howell & Frost, 1989; Howell & Higgins, 1990; Keller, 1992; Koh, Steers, & Terborg, 1995; Lowe, Kroeck, & Sivasubramaniam, 1996; Sosik, 1997; Yammarino, Dubinsky, Comer, & Jolson, 1997; Yammarino, Spangler, & Bass, 1993). Furthermore, research still continues to link leadership and performance to trait-based measures (Smith & Foti, 1998; Zaccaro et al., 1991), personality measures (Deluga, 1998; Judge & Bono, 2000; Kuhnert & Lewis, 1987; Salgado, 1998; Simonton, 1988), personality motives (House, Spangler, & Woycke, 1991; Spangler & House, 1991), and emotional intelligence (Barling, Slater, & Kelloway, 2000; Caruso, Mayer, & Salovey, 2002; Palmer, Walls, Burgess, & Stough 2000; Sosik & Megerian, 1999). Why then is a new perspective to viewing leadership required?

First, existing approaches are limited because they cannot explain what leaders know that enables them to act in effective ways. Second, trait-based measures leave much variance unaccounted for when predicting leadership outcomes (Hedlund et al., 1998; Sternberg et al., 2000; Wagner, 1987; Wagner & Sternberg, 1985, 1990). Third, personality and emotional scales seem to be largely unrelated to practical intelligence (Wagner & Sternberg, 1990). We believe that these limitations have created a gap that can be filled by our tacit-knowledge approach. For example, Blair and Hunt (1985) stated, "Leadership on the future battlefield is an extremely complex topic and requires one to go beyond the boundaries of most traditional academic leadership studies" (p. 271). In this report, we will demonstrate how our approach extends these boundaries. In the next section, we explore some of these challenges that the military faces, and how tacit knowledge and its development is crucial to leadership effectiveness.

Tacit Knowledge in Military Leadership

The U.S. Army defined leadership as "influencing people—by providing purpose, direction, and motivation—while operating to accomplish the mission and improving the organization" (U.S. Department of the Army, 1999, section 1-4). The Army noted that the skills that are important for direct leaders (i.e., first-line leaders including team, squad, section, platoon, company, and battalion leaders) include *interpersonal, conceptual, technical,* and *tactical* skills. The Army also noted that those same skill sets—although operationalized differently—are applicable to organizational and strategic leaders (i.e., leaders who lead others indirectly with the aid of staff and subordinate commanders). Although it appears that conceptual skills might be most related to tacit knowledge, all other skill areas are, in part, a function of the experiences individuals have and hence their tacit knowledge. Individuals learn their trade experientially, and experiential learning is a common denominator of all skills, whether interpersonal, motor, or tactical. For the Army, it is thus important that the experiential processes that form the foundation of practical knowledge are better understood so that they can be harnessed for organizational effectiveness.

The U.S. Department of the Army (1999) stated that leadership development is supported by three pillars: (a) institutional training, (b) operational assignments, and (c) self-development. Operational assignments include on-the-job learning that provide opportunities for experiential and vicarious knowledge acquisition. The importance of operational assignments cannot be stressed enough. Sternberg and his colleagues argued that much of the knowledge individuals—

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and hence leaders—require to succeed in life, is acquired experientially. It is that knowledge which discriminates successful from less successful individuals (Sternberg et al., 1995, 2000; Sternberg, Wagner & Okagaki, 1993). Furthermore, measures of tacit knowledge or practical intelligence have been found to correlate positively with subjective or objective on-the-job performance criteria (Hedlund et al., 1998; Pulakos, Schmitt, & Chan, 1996; Sternberg et al., 2000; Wagner, 1987; Wagner & Sternberg, 1985; Wagner, Sujan, Sujan, Rashotte, & Sternberg, 1999).

According to Sternberg et al. (2000), operational assignments "provide a context for acquiring new knowledge about leadership—knowledge that may not be well supported by doctrine or formal training" (p. 169). Many scholars have cited the importance of experience as compared to formal training for the development of job-related knowledge (Davies & Easterby-Smith, 1984; Keys & Wolfe, 1988; Kotter, 1982; McCall, Lombardo, & Morrison, 1988; Mintzberg, 1975). However, the ability of individuals to learn experientially depends in part on how individuals utilize their cognitive resources. As a result, the importance of the cognitive dimension of leadership as it applies to leadership effectiveness in the military has been noted by many (e.g., Isenberg, 1985; McGee et al., 1999; Sherman et al., 1999; Wong & Duran, 1999; Yukl, 1999). As applied to the Army, Yukl (1999) stated:

> To adapt to increased complexity in the environment and the rapid pace of change requires strategic cognitive skills. . . . One essential competency for coping with increasing complexity and change is the ability to learn from experience, including the person's earlier life experiences as well as more recent job-related experiences. A key aspect of learning from experience is to introspectively analyze one's own cognitive processes (e.g., the way one defines and solves problems) and find ways to improve them. . . . This competency . . . is required to develop better mental models for interpreting feedback, understanding dynamic processes, and visualizing relationships among the different parts of the system. (p. 264-265)

Below we explain some of these cognitive skills, and how they are geared towards environmental adaptation. We introduce the triarchic theory, and relate this theory to functions of leadership and management.

The Triarchic Theory of Intelligence

In attempting to address the restricted way in which intelligence is viewed, Sternberg (1985, 1988, 1997) proposed a triarchic theory of successful intelligence. The basic tenet of this theory is that intelligence can be viewed as an interplay of how individuals achieve personal success within their environment, by using their analytical, practical, and creative abilities. Central to Sternberg's (1988) definition of intelligence is the individual's "*purposive adaptation to, selection of, and shaping of real-world environments relevant to one's life and abilities*" (p. 65). This view of intelligence is somewhat similar to Jacques's (1986) notion of cognitive power, which he defined as "the ability of individuals to form and pattern the world in which they live in a manner that allows them to construct goals and organize their approaches to achieving them" (p. 382). Sternberg's theory of successful intelligence seeks to explain the manner in which the internal world of the individual relates to the external world of the individual, and how this relationship is mediated by experiences that the individual has. The internal world relates to the

cognitive processes that affect behavior, and the external world relates to the process of environmental adaptation. This theory has three aspects:

1. The componential subtheory relates intelligence to the internal world of individuals, and how knowledge is acquired, how problems are framed, how inferences are made, and how problem-solving outcomes are monitored.

2. The contextual subtheory relates intelligence to the external world, and how individuals adapt to, select, and shape their environments.

3. The experiential subtheory relates intelligence to the internal and external world of individuals, and how they cope with novel or familiar situations.

On a broad scale, intelligence can be viewed as the interaction of the three subcomponents of the theory, that is, how the *metacomponents* are applied to *experience* for the individual to *adapt* to the external environment (Sternberg, 1988). Sternberg (1988, 1997) argued that intelligence is not limited to the traditional notion of "g," that is, a general intelligence factor that is associated with analytical intelligence. Rather, intelligence includes also creative and practical abilities. General intelligence tests, however, are restrictive, and typically measure "(a) the outcomes of knowledge-acquisition components (via tests such as vocabulary and reading) and (b) the current functioning of performance components" (Sternberg, 1988, p. 70).

As regards practical intelligence, the proposition that measures of this construct (or tacit knowledge) are generally not correlated with measures of g, appear to measure other elements of intelligence not accounted for by g, and predict variation in outcomes above and beyond measures of g, has found empirical support (Fox & Spector, 2000; Hedlund, Plamondon et al., 2001; Hedlund et al., 1998; Pulakos et al., 1996; Sternberg et al., 2000; Wagner, 1987, 2000; Wagner & Sternberg, 1985, 1990). Furthermore, tacit-knowledge subscores within a domain appear to correlate with one another, suggesting that they may be measuring an overarching factor of tacit knowledge (or possibly practical intelligence) different from the g factor measured by general intelligence tests (Wagner, 1987; Wagner & Sternberg, 1985). Also, tacit-knowledge scores tend to correlate across domains suggesting that there is commonality in the tacit knowledge (or practical intelligence) required in different professions (in this case business managers and academic psychologists) (Wagner, 1987). Therefore, in order to better understand intelligence as it relates to human behavior, our views of intelligence must reflect the triarchic theory.

The triarchic theory is also relevant to explaining the purpose of leadership, and how it complements the management function. Drawing from Bass's (1998) distinction between transformational (i.e., focused on transcendent ideals and emotional exchanges) and transactional (i.e., focused on fulfilling contractual obligations) leadership, we view leadership as a highly active process that seeks to influence, develop, and inspire individuals through emotional exchanges, toward a vision that reflects an attractive future outcome. Leadership is clearly linked to environmental adaptation, by shaping and selecting desirable environments—it is focused on change, and is concerned with establishing a mission and purpose. Thus, leadership is an executive process that controls the governing variables of an organizational system. We define management as an active and passive process of establishing and monitoring role and task requirements, by utilizing transactional exchanges for the fulfillment of contractual obligations. Management is focused on the stability the system when the right environment is found.

Management does not question what should be done, but instead supports the executive functions of leadership by focusing on goals, and monitoring how they are executed so that adaptation occurs when the right environment is created or found. Military officers need to be managers and leaders. Depending on the context their success depends on a combination of their analytical, creative, and practical abilities, and, as we document in this report, their tacit knowledge.

Next we investigate the construct of tacit knowledge in detail. We delineate its theoretical boundaries, and examine its antecedents and consequences.

THE NATURE OF TACIT KNOWLEDGE

Lately, there appears to be much interest in understanding cognitive dimensions of leadership (e.g., Fiedler 1993; Kenny & Zaccaro, 1983; Lord & Emrich, 2000; Marshall-Mies et al., 2000; Mumford, Zaccaro, Connelly, & Marks, 2000; Mumford, Zaccaro, Harding, Jacobs, & Fleishman, 2000; Pratch & Jacobowitz, 1997, Zaccaro et al., 1991). In reviewing the literature, Zaccaro and Klimoski (2001) stated that effective leadership must be proactive and reactive relative to environmental changes, and that "organizational leadership can be construed as large- (and small-) scale social problem solving, where leaders are constructing the nature of organizational problems, developing and evaluating potential solutions, and planning, implementing, and monitoring selected solutions within complex social domains" (p. 8). Lord (2001) mentioned, "Human cognitive architectures create, organize, store, retrieve, and operate on symbol structures to construct individualized meanings and invent adaptive responses or retrieve them from memory. Leadership and other social and organizational processes ultimately operate through such cognitive processes" (p. 415). Researchers are also attempting to link cognitive frameworks to neocharismatic models, for example, Antonakis and House's (2001) strategic intelligence factor, Conger and Kanugo's (1998) sensitivity to the environment factor, Sashkin's (1988) conception of the visionary leader who uses heuristics and intuition, and House and Shamir's (1993) adaptive behavior factor. As mentioned earlier, we believe that research in this arena will yield useful findings. These approaches can explain the unexplainables of existing models by focusing on the role of cognition in generating knowledge that can be applied to real-world problems.

Below we examine the nature of tacit knowledge in depth. First, we define tacit knowledge and how it is measured. Then, we examine how tacit knowledge can be used to distinguish experts from novices. Finally, we discuss some dysfunctional consequences of tacit knowledge, and how individuals should monitor the governing variables of their behavior to maximize the utility of their tacit knowledge.

Definition of Tacit Knowledge

The term *tacit knowledge* was coined by Polanyi (1966/1983). Schön (1983) later demonstrated the applicability of tacit knowledge to organizational behavior in explaining how practitioners reflect in action. Horvath, Williams et al. (1994) argued that tacit knowledge has three distinct characteristics: (a) it is procedural and guides action by context-specific rules, (b) it is relevant to personal goal-attainment, and (c) it is acquired through experiential learning and low environmental support. Tacit knowledge is an important component of practical intelligence

that serves as a tool to solve everyday problems (Sternberg, 1997). Tacit knowledge can thus be defined as implicit knowledge that is derived from experience. How effectively and efficiently that knowledge is acquired and used depends on one's practical intelligence. We define practical intelligence as the ability to acquire—experientially—tacit knowledge that is relevant to solving practical problems. Thus, tacit knowledge can be expressed as a function of practical intelligence and experience as follows: Tacit knowledge $= f$ (Practical intelligence*Experience).

<div align="center">Measuring Tacit Knowledge</div>

Research on military leadership undertaken by Sternberg and his colleagues has focused primarily on understanding the role of experiential learning and what type of knowledge it can produce. As with all science, the process of understanding how a construct behaves requires that the construct be reliably measured. To gain a deeper understanding of the construct we must then compare it to other measures that are hypothesized to be similar or different, and also to determine whether our construct actually predicts what it should in theory.

The first phase of this project was undertaken by Horvath, Forsythe, et al. (1994), who interviewed 81 officers from the platoon, company, and battalion levels. The officers identified examples of lessons gained from experience, which were not reflected in doctrine or in classroom situations. Upon completion of the interview process, the interviews were summarized and coded at the platoon, company, and battalion levels, representing Lieutenant, Captain, and Lieutenant Colonel ranks, respectively. An expert panel independently evaluated the summaries and the way they were coded to determine whether they actually represented tacit knowledge, and whether they were accurately coded to reflect the antecedent conditions and consequences of the tacit knowledge concerned. The codings thus represented condition-action mappings that could be used to identify clusters of similar scenarios. The experts made amendments, both individually and as a group, which resulted in 174 coded tacit-knowledge items across the three officer levels. The experts independently sorted the tacit-knowledge items into categories, which were then cluster-analyzed and interpreted by the experts. The items identified by Horvath, Forsythe, et al. (1994) served as the basis for Horvath et al. (1996) to select tacit-knowledge items that could potentially be used as measurement instruments. Once this phase was completed, inventories were created relevant to each officer level. These inventories—referred to as the Tacit Knowledge Inventory for Military Leaders (TKML)—consisted of scenarios depicting an actual event, and alternative courses of action that could be utilized to act on this event.

The scenarios depicted in the TKML are referred to as situational judgment tests (Chan & Schmitt, 1998; Legree, 1995; Motowidlo, Dunnette, & Carter, 1990). Respondents are typically asked to rate the various alternatives that could be taken to act on the event so that a desirable outcome is achieved. In the case of the TKML, these inventories were also administered to experts whose mean scores on the alternative courses of action on the scenarios were used to characterize the "correct" responses. The degree to which individuals exhibit tacit knowledge, is the degree to which their answers correlate with the mean responses of the experts. Hedlund et al. (1998) assessed the criterion validity of the TKML with a measure of g, a tacit knowledge inventory for managers, and with multisource data on the leaders' effectiveness. Hedlund et al. reported that these inventories exhibited adequate validity and reliability based on their preliminary validation study. The complete TKML inventory at the platoon, company, and

battalion levels is documented in Hedlund et al. (1998, 1999a, 1999b, 1999c). The revised inventory contains 15 scenarios at the platoon level, 19 scenarios at the company level, and 13 scenarios at the battalion level. For an example of a scenario, please refer to Appendix A.

An instrument that ostensibly captures domain-relevant knowledge should be able to discriminate more experienced from less experienced individuals. As demonstrated by Hedlund et al., (1998, 2000), the TKML instruments can accurately account for differences in domain-relevant knowledge of more experienced and less experienced military officers. Theoretical reasons for the discriminatory aspect of the instrument are presented next.

Expert-Novice Differences

There is consensus in the literature that experts and novices exhibit different skill sets that are a function of experience, especially when dealing with cognitive tasks (Charnes, Krampe, & Mayr, 1996; Chi, Glaser, & Farr, 1988; Patel & Groen, 1991). Orasanu and Connelly (1995) noted, "Problem-solving studies show fundamental differences between novices and experts in how problems are interpreted, what strategies are devised, what information is used, memory for critical information, and speed and accuracy of problem solving" (p. 11). Drawing from Johnson's (1988) propositions, Orasanu and Connelly stated further that these expert-novice differences are not evident in all domains, because the nature of the task that is being performed moderates expert-novice differences, and that differences are usually greater when tasks are applied to practice. Johnson (1988) noted that in uncertain situations, where standard procedures cannot be applied to solving problems, expert-novice differences are most apparent. Experts know on which cues to focus, and how to integrate those cues into their decision-making model.

As compared to novices, experts also exhibit more sophisticated metacognitive skills, that is, skills that reflect the ability to generate solutions to problems and to monitor outcomes appropriately (Dorner & Scholkopf, 1991; Larkin, 1983; Smith, Ford, & Kozlowski, 1997). Chi, Glaser, and Rees (1982) noted that the schemata experts construct are abstract, and contain procedural knowledge applicable to problems. The schemata of novices, however, represent only declarative knowledge about the configuration of problems. For example, in relating expert-novice differences to medicine, Patel, Arocha, and Kaufman (1999) noted that experts are able to immediately recognize important cues about problems, whereas novices have to make many inferences and think through the problem explicitly.

Apart from the fact that experts have greater knowledge than novices, Means, Salas, Crandall, and Jacobs (1995) stated that experts observe events differently, and the filters they use in this process are tacit. Drawing from Anderson's (1987) perspective of proceduralized knowledge, Means et al. argued that experts "chunk" information into familiar patterns, and selectively attend to information cues. At a novice stage, only factual knowledge is used, and weak strategies are applied to deal with problems. However, "Through repeated attempts of this nature, general strategies become particularized to fit the domain, and production rules linking actions to specific situations become complied into larger and larger units" (Means et al., p. 311). In this way, Means et al. argued that the knowledge of individuals highly skilled in a particular domain is linked to their actions and the conditions under which they may be applied.

In summarizing the literature on expert-novice differences, Chi et al. (1988) noted that (a) experts have a high degree of domain-relevant knowledge suitable only to that domain, (b) experts perceive clusters of information (i.e., patterns) reflecting a sophisticated knowledge-organization base, (c) experts solve problems quickly, (d) experts spend more time defining the nature of the problem while novices typically delve into finding solutions, (e) experts have superior short- and long-term memory, (f) experts represent problems at a substantive rather than at a superficial level, and (g) experts have sophisticated problem-monitoring skills.

As we discuss below, tacit knowledge is obtained with experience. Ericsson and Lehmann (1996) indicated that expertise in a domain might take up to 10 years to acquire, as long as effective learning opportunities are provided. Thus, although it appears that experience and expertise are generally correlated, experience does not necessarily cause expertise. That is, some individuals may learn from experience and hence become experts, while other individuals may not. For example, Argyris (1957) stated, "Experience per se teaches nothing. The way in which the individual uses experience is the crucial factor" (p. 15). Although tacit knowledge appears to increase with experience (Hedlund et al., 2000; Horvath, Forsythe, et al., 1994; Sternberg et al., 1993, 2000; Wagner, 1987; Wagner & Sternberg, 1985; Wagner et al., 1999), as indicated by Sternberg et al. (2000), it can also be negatively correlated with experience.

We believe that experience is a necessary but not sufficient condition for the emergence of expertise. When viewing experience from a time-based perspective, it is evident that this measure does not capture the quality of experience. As established by Ericsson, Krampe, and Tesch-Römer (1993) and Ericsson and Lehman (1996), experience, as measured by number of years in a particular domain, is not necessarily related to performance. Tesluk and Jacobs (1998) argued that experience is not only related to quantitative indicators such as number of years on the job, or number of times a task has been performed, as has been the traditional notion. Rather, experience also has qualitative aspects that relate to the events and situations to which individuals are exposed, how individuals were challenged by those experiences, and whether individuals had opportunities to learn from those experiences (Ericsson et al., 1993; Ericsson & Lehman, 1996; Tesluk & Jacobs, 1998). Furthermore, the relationship between work experience and job performance is moderated by the work-experience measure used (Quinones, Ford, & Teachout, 1995).

Below we examine how experience and tacit knowledge does not always lead to intended consequences. As Argyris (1999) noted, "tacit knowledge is the primary basis for effective management, and the basis for its deterioration" (p. 123).

The Dysfunctional Consequences of Tacit Knowledge

So far, we have viewed tacit knowledge as largely beneficial, and linked its importance to organizational effectiveness. However, tacit knowledge can also be detrimental to organizational success. As Sternberg (1999) noted, "tacit knowledge can be a source of highly effective performance in the workplace. It can also be a source of decline and ultimately of failure" (p. 236). Schön (1983) also conceived of tacit knowledge as being dysfunctional when individuals have "overlearned" their practice and are inattentive to environmental cues. Others have proposed similar arguments (e.g., Argyris, 1994, 1999; Hammond, Keeney, & Raiffa, 1999;

Hatsopoulos & Hatsopoulos, 1999). How can it be that tacit knowledge can lead to deleterious effects?

Argyris (1976, 1994) demonstrated that the basis of individual behavior in organizational settings is governed by unconscious (implicit) feelings, and that these feelings differ from what individuals explicitly espouse. McClelland, Koestner, and Weinberger (1989) have also noted that implicit motives do not correlate with explicit motives, and that, in the long run, behavior is governed by implicit motives. Argyris believed that individuals are unaware of the incongruence between what they espouse and actually do, and characterized those individuals as being governed by a Model I theory of action. As a result of Model I behaviors, Argyris (1994) stated that learning is inhibited in organizations because of defensive routines of individuals who strive to protect themselves and others from potentially embarrassing or threatening situations—what he referred to as "skilled incompetence." Thus, individuals who are oblivious to their defensive routines cannot self-regulate their behavior, and are prone to Model I actions and single-loop learning. This concept of self-regulation is derived from cybernetic systems theory (Boulding, 1985). An example of self-regulation is a thermostat that senses external temperature and turns a burner on or off accordingly. This direct feedback (temperature) and the actions (on/off) that are taken are referred to as single-loop learning by Argyris (1994). The thermostat is not able to question why it is turning the burner on or off, or why the temperature is at a particular setting. In other words, the system does not understand its governing variables. If it were able to do so, it would be double-loop learning (Argyris, 1994). Similar to what Sternberg (1985, 1988, 1997) proposed regarding the use of metacomponential skills in pursuing one's goals, Argyris's concept of double-loop learning entails understanding governing variables of behavior, and concurrently matching desired and actual outcomes.

Argyris (1994) stated that because of the prevalence of the Model I theory of action, individuals are unaware that they are behaving in the manner depicted above, and unaware of the fact that they are unaware. The behavioral framework of the individual, and the knowledge it generates is thus tacit. Model I individuals suppress their feelings, send out mixed signals, and behave in ways that are not congruent with what they truly espouse. To compensate and rationalize their behavioral strategy, they make untestable attributions of others by privately testing their assumptions, and incorrectly believing that these assumptions are valid inferences, which ultimately leads to a self-fulfilling prophecy. Argyris mentioned that humans would not knowingly make errors, and in the event that they did, they would strive to correct them. However, because individuals produce errors by not matching their actual outcomes with what they espouse, and because they are unable to detect this prevalence, behavior is thus governed by the individuals' theory of action and not by what they espouse. As Argyris stated: "If [an individual] decides to act in a way that will produce dysfunctional consequences, then such 'errors' are intended, and hence, there is a match, not an error" (p. 12).

To avoid skilled incompetence, Argyris (1994) contended that individuals must double-loop learn and move toward the Model II theory of action, which has the following governing variables: "valid information, free and informed choice, and internal commitment to choices made in order to monitor the effectiveness of their implementation" (p. 153). The positive outcome of using this model includes the generation of valid knowledge, collaborative learning, and increased trust and risk taking among organizational players (Argyris, 1994). These

outcomes can only occur if individuals are in touch with their feelings, communicate them to others, publicly test their beliefs and attributions of others or of situations, and use the feedback generated from the test to confirm or disconfirm their beliefs. In other words, individuals must be able to reflect on their governing variables and on feedback from the environment. Thus, to the extent that individuals are not aware of the governing variables of their behavior, and cannot use environmental feedback, tacit knowledge can result in dysfunctional outcomes.

In the next section, we investigate the acquisition and utility of tacit knowledge, and present an integrated model of practical intelligence and tacit-knowledge acquisition. We also review how tacit knowledge can be facilitated, and how individuals can acquire tacit knowledge vicariously from others.

<center>Acquisition of Tacit Knowledge</center>

To better understand how individuals acquire tacit knowledge, it is first necessary to understand the cognitive processes involved in conceptualization, and how these processes occur unconsciously. Although there are many theories that propose how concepts are formed, we draw on Rand's (1966/1990) theory to explain concept formation. Rand argued that the process of concept formation develops when individuals begin to sense and even before they can communicate. Individuals recognize and identify what they sense as they become aware of their environment. Thereafter, they construct relationships among what they identify by observing their similarities and differences, and transforming the conceptual relationships into common units. Rand defined a unit as an "existent regarded as a separate member of a group of two or more similar members" (p. 6), and argued that the manner in which units are classified is a function of how they are perceived in situ. Concepts are later symbolized by words and refer to "a mental integration of two or more units possessing the same distinguishing characteristic" (Rand, 1966/1990, p. 13). The units can refer to any aspect of what is perceived, for example attributes, actions, entities, and so forth. In this example of concept definition, it is obvious that our ability to conceptualize is tacit, because our knowledge of the world and the way it is constructed begins early on in life, before we can communicate or identify how concepts are acquired. Given the amount of conceptualization individuals undertake throughout their lifetimes, it is apparent that this process is highly automatized, and that individuals are not always aware that it is occurring.

We have defined tacit knowledge, set tacit knowledge within a broader framework of practical intelligence, identified that tacit knowledge is acquired experientially, and established how concepts are formed; however, we have not expounded on how precisely tacit knowledge per se is acquired. According to Sternberg (1988), an individual's knowledge-acquisition components generate knowledge of the external world by selectively encoding, combining, and comparing information. By selectively encoding, individuals attend to relevant information as they acquire new knowledge. Selective comparison entails discovering relations between old and new information. Knowledge can also be acquired by selectively combining information to form a cohesive and integrative knowledge superstructure. The knowledge-acquisition process is analogous to the concept-formation process discussed earlier. However, the knowledge-acquisition process is not merely constrained to concept formation, but extends it to represent integrations, relations, and causal processes of concepts that represent phenomena.

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Sternberg (1988) argued that the information-processing (i.e., knowledge-acquisition) components are activated, and work with higher-order metacomponential processes to solve problems. These metacomponential processes include recognizing that problems exist, defining the nature of the problem, generating courses of action to solve the problem, selecting appropriate strategies to solve the problem, representing information about the problem, allocating resources to solve the problem, and monitoring solution outcomes. The instructions of the metacomponents are executed by the performance components. These components govern inferences that are made about the problem, causal relations that link elements of the problem, and the application of knowledge gained to solving the problem. These three kinds of components—knowledge-acquisition components, metacomponents, and performance components—form the processes that undergird cognitive functioning.

To further explain the practical nature of the aforementioned components and how they apply to practical problem-solving, we draw on Schön's (1983) theory of reflective practice. Schön suggested that a practitioner's competence appears as nearly spontaneous action that is based more on intuition than on rationality, a proposition supported by others (e.g., Isenberg, 1985, 1986; McCall & Kaplan, 1985; Mintzberg, Raisinghani, & Theoret, 1976). Klein (1995) noted that experienced leaders are characterized by "generating, monitoring, and modifying plans to meet the needs of . . . situations" (p. 139). Rather than compare contrasting options and then choosing between them, as suggested by some theorists, Klein argued that experienced individuals use their experience to immediately adopt what they think is the best course of action, and then put it to the test. Thus, individuals solve problems with an intuitive or tacit approach, rather than some rigorous analytic cognitive strategy. Schön argued that by recognizing patterns of events in their experiences, individuals create frameworks and schemata—most of which are latent—to make sense of their experiences. These schemata, and hypotheses that are derived from them, are then tested in practice. Individual actions and hypotheses are continually updated as they receive feedback from their actions, as environmental conditions change (Bandura, 1977; Schön, 1983). In the process of testing different approaches to solving problems, "early mistakes generate information that allows corrective action later (including dealing with side effects of the early actions)" (Orasanu & Connolly, 1995, p. 9). In this way, individuals are able to understand causal relationships that may occur, and as Senge (1991) noted, are able to understand systems processes and link cause to effect, whether they exist in the same or in a different temporal and spatial dimension.

Through repetition, Schön (1983) noted that individuals produce automatic and spontaneous responses to cases that are similar. However, individuals must also reflect on this implicit knowledge, lest it lead to erroneous outcomes, especially in novel environmental conditions. Thus, when encountering new situations, individuals must test their schemata in practice and reflect on the outcomes to fine-tune their knowledge in those contexts. In this way, they become researchers in the context of practice (Schön, 1983). Individuals must thus reflect on their tacit knowledge, particularly when their tacit knowledge is no longer applicable and may result in a mismatch of outcomes and intentions (Argyris et al., 1985).

Based on the above explications of tacit knowledge, it appears that all individuals should be capable of acquiring tacit knowledge. Furthermore, varying degrees of experience should account for differences in expertise in individuals, assuming that individuals are capable of

effectively learning from their experiences. Thus, individuals who are experts in a certain domain must have acquired this expertise as a result of their extensive experience, while lack of experience should be indicative of individuals who are novices in a certain domain.

Next, we present an integrated framework of practical intelligence and tacit-knowledge acquisition, based primarily on Sternberg's triarchic theory (1985, 1988, 1997), and in part, on Schön's (1983) theory of the reflective practitioner and Argyris's (1976, 1994) Model II theory of action.

A Model of Practical Intelligence and Tacit-Knowledge Acquisition

In this section we present an explanatory model of practical intelligence and tacit-knowledge acquisition. The processes that underlie intelligent functioning, as represented in this framework, are tacit. Furthermore, the processes that we model are fluid. They do not occur discretely, but rather in parts, as and when information or action is required. This model represents the componential subtheory of the triarchic theory as it applies to the experiential subtheory, which enables the individual to adapt to the external environment.

We will illustrate the cognitive processes underlying this model as they apply to a hypothetical person, Sue, who is a captain in the U.S. Army. Assume that Sue experiences an event, and that this event reflects an encounter with an insubordinate soldier. This event is problematic to her because it represents a state of existence that is incongruent with her individual goals. She would like to maintain her credibility as a commander, but this solider is undermining her authority. Sue seeks to change this situation by shaping her environment. The cognitive processes underlying this adaptation process can be captured by the model depicted in Figure 1. The shaded parts of the model indicate elements of Sternberg's (1985, 1988, 1997) componential subtheory.

As can be seen in this model, Sue acquires knowledge of this event, and selectively attends to and encodes relevant information. She sees information in "chunks," that is, the entire context of the encounter and chains of events. For example, she notices what the soldier said, his body language, whether anyone else witnessed the encounter, when the encounter was held, what occurred before the encounter, and so forth. Whatever information is relevant and required to solve the problem is encoded. Sue also gains knowledge by selectively comparing old to new information to determine what relations exist between those discrete representations, and how the old information can be used and relates to new information. Sue can also acquire knowledge by selectively combining previous patterns of information to determine how those discrete pieces relate to each other, and how they can be formed into an integrated structure. This process of knowledge acquisition is activated by Sue's metacomponents, which draw on knowledge gained by the knowledge-acquisition components (feedback arrow #1) in order to represent the problem encountered in the environment, and to begin a strategy to solve it. Depending on what problem has been recognized and how it has been defined, the metacomponents trigger an abstraction process whereby information that is relevant is distilled with old tacit knowledge that together can be applied to the problem.

Based on the information the metacomponents receive from the knowledge-acquisition components (feedback arrow #1), the metacomponents concurrently generate an appropriate

course of action to deal with the problem, and how its outcomes will be monitored. The metacomponents thus activate the performance components. The performance components govern which knowledge will be applied to the problem, what inferences will be made about the problem, and how the instructions of the metacomponents will be executed to solve the problem.
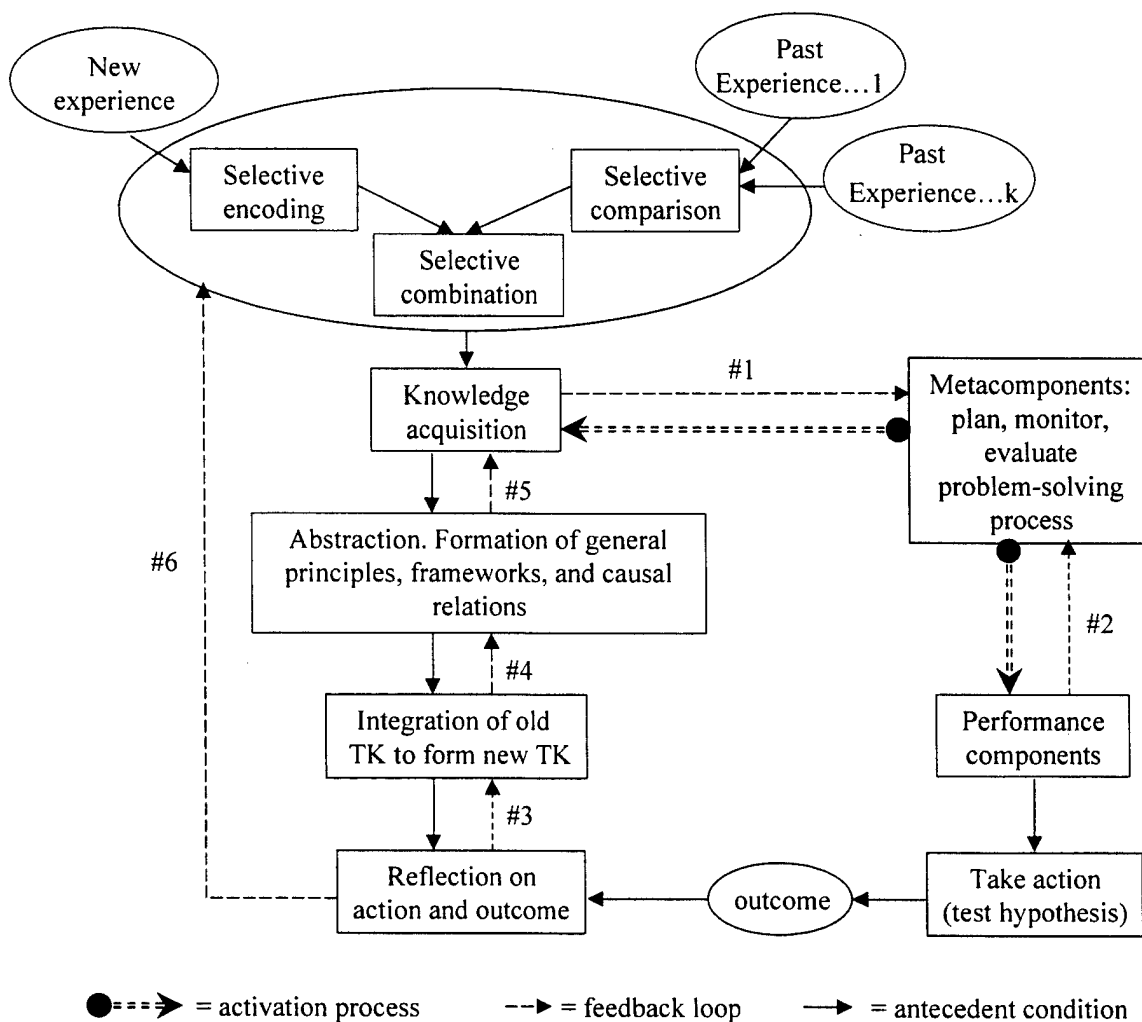
Figure 1
A Model of Practical Intelligence and Tacit-Knowledge Acquisition

The performance components provide feedback to the metacomponents (feedback arrow #2), which refine the strategy if required, draw further knowledge from the knowledge-acquisition components if required, and finally settle on the problem-solving plan. The performance components predict or hypothesize the outcome that will occur, and adjust the action that will be executed as directed by the metacomponents. Action is then taken—the hypothesis that will ostensibly solve this problem is tested, resulting in an outcome.

Let us assume that the action taken was a UCMJ Article 15 (Uniform Code of Military Justice disciplinary action), which resulted in subduing the soldier. Sue then reflects on the

action taken and on the resulting outcome to provide feedback to the distilled tacit knowledge (feedback arrow #3), to verify whether the knowledge applied was correct. This feedback then informs and updates the general principles, frameworks, and causal relations (feedback arrow #4). In this way, Sue's schemata are continuously updated to reflect the subtle nuances of the problem at hand. If this process was wrongly executed, or if the outcome was unintended, feedback is provided to the metacomponents and the performance components (feedback arrows #5 and #1) to adjust the action accordingly. Feedback is also provided to the knowledge-acquisition components (feedback arrow #6), which can use this information to re-encode, re-compare, and re-combine information useful for the metacomponents. In this way, Sue uses her metacomponents to reframe the problem if necessary, and reconsider the current action or plan a new course of action. If the problem is solved, Sue has adapted to her environment by shaping it. According to our framework, Sue has demonstrated the process underlying intelligent behavior.

On a theoretical level, we assume that individuals with experience can more readily adapt to novel conditions as compared to individuals with less experience. This can only occur if those with experience can reflect on their actions and frameworks. Therefore, how tacit knowledge is generated and used is a function of an individual's capacity to learn and use environmental feedback.

Facilitating Tacit-Knowledge Acquisition

A key issue for all organizations—including the military—is whether the cognitive processes that undergird tacit-knowledge acquisition can be accelerated or facilitated. Enhancing the acquisition of tacit knowledge would solve many challenges that all organizations face with regard to the increased tempo of change, downsizing, and so forth. How might this process be facilitated? Analogous to the adage of teaching hungry individuals how to produce food, instead of simply providing them with food, we could either teach individuals how to monitor their knowledge-acquisition processes, or simply provide them with what they need to know. Certainly, a combination of the two approaches is needed. However, empowering individuals' ability to think and learn is very important for three reasons: (a) individuals will be able to make the right decisions, (b) individuals will be able make decisions faster, and (c) individuals will require less formal training. As right decisions are made faster with less training, an obvious benefit for the organization is that it requires less resources to pursue its strategies.

Although we believe that it is possible to improve the cognitive processes of individuals, we do not believe that such efforts are substitutes for experience. Experience is critical to acquiring tacit knowledge. Without experience, tacit knowledge cannot be generated. Thus, interventions must be built around experiences or within experience because, as noted by Means et al. (1995), the ability to recognize patterns can only occur from repetitive exposure to those patterns. It is also clear that not all individuals would benefit from training interventions, and we would expect that the efficacy of intervention strategies would vary as a function of individuals' cognitive development.

Horvath, Forsythe, et al. (1994), and Sternberg et al. (2000) argued that it is possible to facilitate the acquisition of tacit knowledge through training interventions, both in the classroom and on-the-job. Others have argued or demonstrated that on-the-job reflection can be facilitated, and interventions can enable individuals to better utilize their tacit knowledge and cognitive

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processes (Argyris, 1994; Lubit, 2001; Schön, 1983; Seibert, 1999; Smither & Reilly, 2001). Halpern (1998) argued that metacognitive-teaching strategies could be used to improve decision making. Klein (1997) reported that decision-making skills can be taught, including situational awareness, sensitivity to patterns and cues, recognition of typical cases or anomalies, construction of mental models, extending the temporal view of event chains, and metacognitive skill development. Klein stated that these interventions can be achieved through a variety of training methods, including, among others, the use of case-based scenarios, provision of feedback, contrasting expert-novice differences, listing common decision failures, and on-the-job training to increase contextualized practice. Sternberg et al. (1993) reported the results of an experiment by Okagaki, Sternberg, and Wagner, and noted that tacit-knowledge acquisition can be facilitated by providing individuals with cues on selective encoding and combination.

In terms of our explanatory model of practical intelligence and tacit-knowledge acquisition, and based on the literature reviewed above, we believe that interventions may be centered on any of the elements of the componential sub-theory or on the feedback loops. In other words, individuals could be trained to better utilize their knowledge acquisition skills, their metacomponential skills, and their performance component skills. Furthermore, individuals could be trained to better reflect on their actions, and to use environmental feedback to improve their decision-making processes.

Next, we examine vicarious learning—another element of tacit-knowledge acquisition. As will be evident, there is reason to believe that individuals can learn from others, particularly leaders.

The Cascading Effect of Tacit Knowledge

Bass, Waldman, Avolio, and Bebb (1987) reported that leaders affect the leadership behaviors of their subordinates through what they termed a "cascading effect." Bass et al. argued that active forms of leadership, for example transformational leadership or constructive transactional leadership, provide modeling behaviors that are emulated by followers. Because behaviors are preceded by the possession of knowledge, it is reasonable to believe that individuals can learn behaviors from others by acquiring knowledge vicariously. As noted by Bandura (1977), individuals learn "symbolically through central processing of response information before it is performed. By observing a model of the desired behavior, an individual forms an idea of how response components must be combined and sequenced to produce the new behavior" (p. 35).

According to Schön (1983), tacit knowledge can spread by contagion as followers observe their leaders in action. Lubit (2001) argued that individuals can acquire tacit knowledge by observing others—notably more experienced individuals (e.g., managers). Lubit stated that this learning process could be further facilitated when those experienced individuals "think aloud." Individuals can also acquire tacit knowledge on the job while being coached by others who are more experienced (Lubit, 2001). House and Shamir (1993) noted that followers learn vicariously from their leaders, and that this process occurs nonconsciously as a result of implicit needs that are aroused in followers by leaders. Others have characterized leaders as being role models for followers, that is, they demonstrate to followers how objectives can be reached (Bass, 1998; Conger & Kanugo, 1998; Sashkin, 1988). The reason why leaders serve as role models for

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followers is because effective leaders are symbols of emulation and identification (Bass, 1985; House, 1977). Furthermore, as Bandura and Walters (1963) noted, modeling effects may be more pronounced when the social model that is emulated has status or prestige.

The "cascading effect" of tacit knowledge is reflected in the policy and practice of leadership development of the Army. Doctrine states that senior leaders should serve as role models to junior officers, whom they should develop, mentor, and coach (U.S. Department of the Army, 1999). Military doctrine also mentions the importance of vicarious learning, and stresses the importance of watching and learning leadership skills from experienced leaders and peers. Based on the hierarchy of the Army, we would expect that Captains—as company commanders—serve as role models for their Lieutenants. We would expect that Captains would spend much time with their Lieutenants coaching, guiding, and correcting them as necessary. We can also assume that Captains have what most Lieutenants see as a position high in status and prestige. Because Captains are their Lieutenants' leaders, we would expect that Captains who are successful and effective become role models and objects of emulation for their Lieutenants. We would thus expect that Lieutenants would learn vicariously from their Captains. The same analogy can be used to describe the relations between a Lieutenant Colonel and his/her Captains. Thus, tacit knowledge should transfer between adjacent levels, that is, from Captains to Lieutenants, and from Lieutenant Colonels to Captains. Given the little amount of contact that Lieutenants would have with their Lieutenant Colonels, we would expect that those two groups would share less tacit knowledge between them. Thus, we propose that tacit knowledge is more related between adjacent levels of leadership, than between nonadjacent levels.

Summary of Findings on Tacit Knowledge

As a construct, tacit knowledge exists and can be reliably measured, and appears to distinguish more experienced from less experienced individuals. Tacit knowledge is acquired experientially and vicariously, and increases with experience if individuals are capable of learning from experience. Tacit knowledge is (a) positively related to performance outcomes in military leaders, (b) unrelated to personality measures and general cognitive ability measures, and (c) accounts for variation in outcomes over and above those other measures.

STUDIES AND SAMPLE

In this section we present three studies that empirically tested hypotheses that were deduced from the literature reviewed. In each of the three studies, we present the hypotheses, the method, and the results, and discuss the findings relative to those results. We then integrate the findings of the three studies, and discuss their implications and limitations.

The data used in these studies were collected from officers at ten Army posts. The officers represented four military ranks: Lieutenants, Captains, Majors, and Lieutenant Colonels. Sample sizes by military rank and site for the data gathered are represented in Table 1. Because all officers did not complete all measures, sample sizes for the various analyses are reported separately. Data were gathered during "umbrella weeks," that is, periods during which officers are available to support research and development efforts.

The purpose of Study 1 was to determine the extent to which military rank was related to tacit-knowledge scores, and whether military rank was related to the experiences depicted in the Tacit Knowledge Inventory for Military Leaders (TKML) instruments. We also sought to establish whether more experienced officers performed better than less experienced officers on the TKML instruments. In this study, we attempted to determine whether support could be found for the "cascading effect" of tacit knowledge. As noted previously, we proposed that tacit-knowledge and officer experiences would be more related at adjacent levels of military rank than at nonadjacent levels. In other words, Lieutenants and Captains should share more experiences and tacit knowledge than Lieutenants and Lieutenants Colonels.

Table 1
Sample Sizes by Site and Rank

SITE	LT	CPT	MAJ	LTC	Total
Sill	14	6	5	6	31
Eustis	9	8	4	11	32
Bragg	5	11	13	2	31
Campbell	7	9	7	9	32
Lewis	9	15	10	-	34
Bliss	11	14	12	8	45
Drum	14	14	14	15	57
Hood	12	13	10	-	35
Riley	10	10	12	12	44
Carson	6	6	6	7	25
Total	97	106	93	70	366

Note: LT = Lieutenant; CPT = Captain; MAJ = Major; LTC = Lieutenant Colonel

The purpose of Study 2 was to contrast differences in metacognitive skills between more experienced and less experienced officers. In this study, we sought to determine what information officers used when solving a practical leadership-related problem, the strategies they employed to solve the problem, and how they intended to monitor the outcome.

In Study 3 we sought to determine the extent to which tacit-knowledge scores of officers would be affected after a short, facilitated discussion. In other words, we sought to discover whether individuals could learn vicariously from others, and whether this learning would be evident in differences between tacit-knowledge scores before the intervention, as compared to tacit-knowledge scores after the intervention.

To the extent that the results confirmed our predictions, our model of practical intelligence and tacit-knowledge acquisition will find tentative support. That is, when viewing intelligence—and in particular practical intelligence—as a form of developing expertise, our instruments should be able to discriminate between officers that are experienced as compared to officers that are less experienced. The differences between those groups of officers should be a

function of military rank, since rank reflects years of experience and the ability to have learned from that experience. Furthermore, the differences between those two groups of officers should be reflected in how they utilize the metacognitive skills depicted in our model of practical intelligence and tacit-knowledge acquisition.

Study 1—The Relation of Military Rank to Experience and Tacit Knowledge

Hypotheses

$H1_a$ *Officer experiences, similar to those depicted in the TKML instruments, will be more related to higher than to lower levels of military rank.*

$H1_b$ *Tacit-knowledge scores, as measured by the TKML instruments, will be more related to higher than to lower levels of military rank.*

Military rank should have the least association with officer experience and tacit-knowledge scores at the platoon level, because all officers—including lieutenants—have had experience at the platoon level, and thus the rank-appropriate tacit knowledge. Military rank should have the most association with officer experience and tacit-knowledge scores at the battalion level, because only battalion commanders have had experience at that level.

We noted earlier that experience and tacit-knowledge may not necessary be related because of the qualitative aspects of experience, and the possibility that individuals do not learn equally from experience. In the case of the Army, because military rank—an ostensive proxy for experience and tacit knowledge—indicates that the officer was promoted as a result of satisfactory performance at a lower rank, we would expect that military rank would be related to officer experiences.

$H2_a$ *Tacit-knowledge scores of officers at adjacent levels will be more closely related than their tacit-knowledge scores at nonadjacent levels.*

$H2_b$ *Experiences of officers at adjacent levels will be more closely related than their experiences at nonadjacent levels.*

Given the argumentation regarding the cascading effect of tacit knowledge, we expected that tacit-knowledge scores and officer experiences would be related at adjacent levels. This expectation is based on the premise that platoon and battalion commanders share little in terms of knowledge and experience, as compared to platoon and company commanders. Thus, more frequent interaction is expected between officers at adjacent levels of command, and this interaction should positively affect the correlations of (a) officer tacit-knowledge scores, and (b) officer experiences, at adjacent levels.

$H3_a$ *More experienced officers will perform better than less experienced officers on all versions of the TKML.*

$H3_b$ *Officers will perform best on TKML tests that reflect their rank.*

Tacit knowledge should increase as rank increases, because higher ranking officers presumably have more experience. As a result of their experience, higher ranking officers should

score better than lower ranking officers on the tacit-knowledge tests. Also, officers should be competent at their level of command, and their day-to-day experiences should be reflected in the scenarios of their level of command, but less so at higher levels. They should thus perform best on tests reflecting their level or below, and worst on tests at higher levels, because they have not had many experiences at higher levels. Finally, we expected that tacit-knowledge score differences will be more evident at the battalion level than at the platoon level, because all officers have had experience at the platoon level, but only Lieutenant Colonels have had experience at the battalion level.

Method

We used the three versions of the TKML to gather cross-sectional data at all sites. The three versions used included (a) the PLQ (Platoon Level Questionnaire), (b) the CCQ (Company Commander Questionnaire), and (c) the BCQ (Battalion Commander Questionnaire) (refer to Appendix A for an example of a TKML scenario). Depending on the site, officers were provided with either all the TKML scenarios, or specific TKML scenarios relative to their rank. Officers were then asked to rate the response options presented in the scenarios. In addition, we asked officers to indicate whether they had experienced a situation similar to that depicted in the scenario, or whether they knew of anyone who had experienced a situation similar to that depicted in the scenario. The reason for requesting this information was to obtain an alternative measure of experience, because as we discussed in the review of the literature, time measures of experience may be limited.

To ascertain the relation of military rank to tacit-knowledge scores and experience, we designated military rank on the following continuous scale: 1 represented Lieutenants (LT), 2 represented Captains (CPT), 3 represented Majors (MAJ), and 4 represented Lieutenant Colonels (LTC). To determine the relation of officer experience to the other measures, we asked the following question with each of the TKML scenarios: "Has any situation like this happened to you or someone you know? If so, please explain." Affirmative responses were coded as "1" and negative responses as "0." The point biserial correlation was then utilized to determine the correlation of experience with military rank.

Results

Responses to the TKML instruments were scored by correlating the officers' ratings provided for response options with the mean expert ratings. These results provided an index of the proximity of the participant's response profile with that of the experts, and thus an indicator of their level of tacit knowledge relative to those of experts. We analyzed these scores to compare differences across ranks, to compare tacit knowledge at different leadership levels, and to assess how experience with similar situations was related to rank. Because we used correlation scores in some of our analyses as variables of a distribution, these correlations were transformed to Fisher z' values. Cohen and Cohen (1983) noted that correlation coefficients may not satisfy assumptions of normality and equal variances, and that these coefficients are "more likely to relate linearly to other variables if the r's are transformed by the Fisher z' transformation" (p. 271). This transformation yields the inverse of the hyperbolic tangent of the original r-value. The r-values that we report are retransformed values (i.e., the hyperbolic tangent of the z' value).

H1ₐ, which stated that officer experiences, similar to those depicted in the TKML instruments, would be more related to higher than to lower levels of military rank, received partial support. Confirming our prediction, military rank correlated least with PLQ scenario experience, and this correlation was insignificant, $r(47) = .12$, ns. Military rank correlated significantly with CCQ scenario experience, $r(55) = .48$, $p < .01$, and with BCQ scenario experience, $r(54) = .32$, $p < .05$. Although we had predicted that the relation of military rank to BCQ experience would be more pronounced than that of CCQ this prediction was not supported. We used the z-test for differences between correlations to determine if the differences between the correlations were statistically significantly (Cohen & Cohen, 1983, p. 54). Confirming our expectations, results indicated that the PLQ and CCQ correlations were statistically different, $z = 1.96$, $p < .05$ (one-tailed test). Contrary to expectations, the difference between the PLQ and BCQ correlations was, however, not significant.

H1ᵦ, which stated that tacit-knowledge scores, as measured by the TKML instruments, would be more related to higher than to lower levels of military rank, received partial support. Confirming our prediction, military rank correlated least with PLQ tacit-knowledge scores, and this correlation was insignificant, $r(71) = .19$, ns. Furthermore, military rank correlated significantly with CCQ tacit-knowledge scores, $r(74) = .32$, $p < .01$, and with BCQ tacit-knowledge scores, $r(75) = .25$, $p < .05$. Although we had predicted that the relation of military rank to BCQ tacit-knowledge scores would be more pronounced than that of CCQ tacit-knowledge scores, this prediction was not supported. The z-test indicated that the difference between the PLQ and CCQ, and the PLQ and BCQ correlations was not significant. Although an effect does appear to be prevalent, due to the limited size of the samples for this analysis, we presume that there may have been insufficient power to detect the effect.

H2ₐ, which stated that tacit-knowledge scores of officers at adjacent levels would be more closely related than their tacit-knowledge scores at nonadjacent levels, was not supported. Confirming our prediction, the relations between tacit-knowledge scores at adjacent levels were positive and significant, and these relations were higher than those of nonadjacent levels, which were also positive and significant. Specifically, PLQ tacit-knowledge scores were more highly correlated with CCQ tacit-knowledge scores $r(36) = .48$, $p < .01$, than with BCQ tacit-knowledge scores $r(32) = .37$, $p < .05$. Also, as expected, the relations of CCQ tacit-knowledge scores to BCQ tacit-knowledge scores were positive and significant, $r(32) = .56$, $p < .01$. The z-test indicated that the difference between the PLQ and CCQ, and PLQ and BCQ correlations was not significant. As with the previous result, although an effect does appear to be prevalent, due to the limited size of the samples for this analysis, we presume that there may have been insufficient power to detect the effect.

H2ᵦ, which stated that experiences of officers at adjacent levels would be more closely related than their experiences at nonadjacent levels, was not supported. As predicted, the relations between experiences at adjacent levels were positive and significant, and these relations were higher than those of nonadjacent levels, which were positive but insignificant. Specifically, PLQ experiences were more highly correlated with CCQ experiences, $r(21) = .53$, $p < .01$, than with BCQ experiences, $r(17) = .28$, ns. As expected, the relations of CCQ experiences to BCQ experiences were positive and significant, $r(16) = .65$, $p < .01$. The z-test indicated that the difference between the PLQ and CCQ, and PLQ and BCQ correlations was not significant.

Again, an effect does appear to be prevalent, but due to the limited size of the samples for this analysis, we presume that there may have been insufficient power to detect the effect.

In order to examine the rank effects, we conducted ANOVAs on each version of the TKML to examine mean differences in scores across ranks. The means are presented in Table 2.

Table 2
Mean Tacit-Knowledge Scores on the PLQ, CCQ and BCQ by Rank.

	LT	CPT	MAJ	LTC	Total
PLQ	.67	.70	.70	.72	.69
	(40)	(11)	(6)	(14)	(71)
CCQ	.63	.72	.69	.76	.71
	(13)	(43)	(4)	(14)	(74)
BCQ	.63	.67	.69	.72	.69
	(11)	(7)	(30)	(27)	(75)

Note: Samples sizes indicated in parentheses. PLQ = Platoon Leader Questionnaire; CCQ = Company Commander Questionnaire; BCQ = Battalion Commander Questionnaire.

H3$_a$, which stated that more experienced officers would perform better than less experienced officers on all version of the TKML, was partially supported. Scores on the TKML inventory generally increased with rank. In other words, senior officers performed better than junior officers on the TKML measures, with the exception of Majors, who scored worse on the CCQ as compared with Captains, and scored the same on the PLQ as compared with Captains. The differences in tacit-knowledge scores were not significant at platoon and battalion level, but were significant at company level as presented in Table 3.

Table 3
ANOVA of Tacit-Knowledge Scores by Rank

Source	df	F
Rank (PLQ)	3	.84
Rank (CCQ)	3	3.87*
Rank (BCQ)	3	1.98

25

Last, we followed up the above analyses with repeated measures ANOVA to examine differences in scores as a function of the test version. Thus, only officers who took all three TKML versions were included in the analysis. Majors were eliminated from these analyses due to insufficient representation. The results of this analysis are reported in Table 4.

Table 4
Mean Tacit-Knowledge Scores by Test Version and Rank

Test Version	LT (n=9)	CPT (n=7)	LTC (n=13)	Overall (n=29)
PLQ	.72	.72	.71	.72
CCQ	.69	.69	.76	.72
BCQ	.65	.67	.71	.69

Note: PLQ = Platoon Leader Questionnaire; CCQ = Company Commander Questionnaire; BCQ = Battalion Commander Questionnaire.

H3_b, which stated that officers would perform best on TKML tests that reflect their rank, was not supported. As shown in Table 4, Lieutenants scored best on the PLQ and worst on the BCQ, but this difference was insignificant. Captains also scored best on the PLQ, and worst on the BCQ. Lieutenant Colonels scored best on the CCQ and exhibited no difference on the PLQ and BCQ. As indicated in Table 5, there were no significant effects for within or between-subject factors across the three measures. However, due to the limited size of the sample for this analysis, there may have been insufficient power to detect any effects.

Table 5
Repeated Measures ANOVA of Tacit-Knowledge Scores by Test Version and Rank

Source	df	F
Test	2	2.32
Rank	2	1.22
Test x Rank	4	1.15

Discussion

Military rank correlated with officer experience at the company and battalion levels. Although we expected that the correlation of rank with officer experience at the battalion level would be higher than the correlation of rank with officer experience at the company level, this hypothesis was not supported. Because these results were counter-intuitive, we sought to investigate why this result occurred. Based on the results of Table 2, the Majors did not perform

as well as expected. For example, they scored the same as Captains on the PLQ, and scored worse than the Captains on the CCQ. Their scores on the BCQ were slightly higher than those of the Captains. In all, the Majors' scores were generally substantially lower than those of the Lieutenant Colonels. Thus, we reran this analysis excluding the Majors. This exclusion was theoretically defensible, given that Majors do not have operational assignments, and are in administrative/staff roles. They do not have experience as battalion commanders. Thus, the tacit knowledge that the Majors have may not be captured in the BCQ scenarios and may stop at the CCQ level. The post-hoc analyses confirmed our rationale, and made the rank effect more evident. The relation of military rank to BCQ scenario experience increased from $r(54) = .32$, $p < .05$, to $r(28) = .52$, $p < .01$, thus surpassing the CCQ scenario experience correlation with rank which was originally $r(55) = .48$, $p < .01$, but which then decreased slightly to $r(53) = .45$, $p < .01$). The relation of PLQ scenario experience to rank decreased slightly, $r(44) = .10$, ns. The z-test for differences between correlations indicated that the difference between the PLQ and BCQ correlations was now significant, $z = 1.88$, $p < .01$ (one-tailed test). The difference between the PLQ and CCQ correlations remained significant, $z = 1.82$, $p < .05$ (one-tailed test). Thus, the post-hoc analyses indicated that *H1$_a$ was fully supported.* As predicted, military rank had the least association with officer experience at the platoon level, where all officers have had experience at that level, and the most association at the battalion level where only Lieutenant Colonels have had experience at that level, and the differences in correlations were significant.

As regards the association between military rank and tacit-knowledge scores, the results did not fully confirm our hypothesis that this association would be the largest at the battalion level, and the smallest at the platoon level. As was evident in the results, the association was the smallest at the platoon level, but greatest at the company level. In view of the arguments presented above regarding the Majors, we reran separate analysis without the Majors. These post-hoc analyses made the rank effect more evident, and the relation of military rank to BCQ tacit-knowledge score increased from $r(75) = .25$, $p < .05$, to $r(45) = .35$, $p < .01$, thus surpassing the CCQ tacit-knowledge score correlation with rank, which was originally $r(74), = .32$, $p < .01$, but which then decreased slightly to $r(70) = .31$. $p < .01$. The relation of PLQ scenario experience to rank decreased slightly, $r(65) = .18$, $p > .05$. The z-test for differences between correlations indicated that the difference between the PLQ and BCQ correlations remained insignificant. The difference between the PLQ and CCQ correlations also remained insignificant, presumably due to the small sample sizes used in this analysis. These post-hoc analyses indicated that *H1$_b$ remained partially supported,* but to a greater degree, because the BCQ correlation had surpassed the CCQ correlation, supporting our theoretical contentions. As predicted, military rank had the least association with tacit-knowledge scores at platoon level—where all officers should have the rank-appropriate tacit knowledge—and the most association at the battalion level where only the Lieutenant Colonels have had the rank-appropriate tacit knowledge; however the differences in correlations were not significant. Thus, overall, the patterns of correlations suggest that tacit knowledge and experience are a function of rank.

The analyses regarding the cascading effect indicated that tacit-knowledge scores and officer experiences were more related at adjacent than at nonadjacent levels. However, these differences were not significant, presumably because of the small sample sizes. For the reasons discussed previously regarding the Majors, we reran separate analysis without the Majors. These post-hoc analyses made the cascading effect more evident and the relation of PLQ experience to

CCQ experience increased from $r(21) = .53$, $p < .05$, to $r(19) = .58$, $p < .01$. The relation of PLQ experience to BCQ experience decreased from $r(17) = .28$, ns, to $r(16) = .16$, ns. The z-test for differences between correlations indicated that the difference between the PLQ and BCQ correlations was marginally significant, $z = 1.34$, $p = .09$ (one-tailed test), thus providing *partial support for H2_b*. As regards the cascading effect and tacit-knowledge scores, the correlations did not change substantially with the removal of the Majors. Thus, an effect appears to be evident, which we presume would be more prevalent if the sample sizes were larger. We argued theoretically that Lieutenants should learn vicariously from Captains, and that Captains should learn vicariously from Lieutenant Colonels, and that this effect should be captured in tacit-knowledge scores and experiences. Although the correlation results followed our theoretical propositions, the nonsignificant results do not allow us to draw the conclusions that Lieutenants and Captains share more tacit knowledge than do Lieutenants and Lieutenant Colonels.

Our proposition that more experienced officers should have higher tacit-knowledge scores across all the items was not fully supported given the nonsignificant result found at battalion level. We again explored the possibility that this aberrant finding could be attributed to the performance of the Majors. Majors scored the same as Captains on the PLQ, and worse than Captains on the CCQ. After removing the Majors from the analysis, we found a significant result at the battalion level $F(2,42) = 3.31$, $p < .05$. The results at CCQ and PLQ level were largely unaffected. Thus, with the Majors removed, the proposition that senior officers would score higher on the tacit-knowledge tests was supported. The Captains scored better than the Lieutenants on the PLQ and CCQ, and the Lieutenants Colonels scored better than the Lieutenants and the Captains on the PLQ, CCQ, and BCQ. As we expected, the differences were significant at the company and battalion levels, but not at the platoon level.

The hypothesis that officers who took all three rank-level tests would score best on the test reflecting their rank or on tests reflecting a lower rank was not supported. On the whole, officers did score best on a rank-level test or on a test at a lower level. Lieutenant and Captains did not score best on higher rank-level tests as we predicted; however, as indicated by the repeated-measures ANOVA, these effects were not significant. We believe that the lack of effect could be attributed to the small sample sizes in the groups (LT $n = 9$; CPT $n = 7$; LTC $n = 13$).

Study 2—Metacognitive Abilities of More Experienced and Less Experienced Officers

<u>Hypotheses</u>

H4_a Less experienced officers will exhibit significantly different metacognitive problem-solving abilities as compared to more experienced officers.

H4_b Metacognitive problem-solving scores of officers will be related to their tacit-knowledge scores.

As the review of literature on expert-novice differences indicated, it is reasonable to predict that on a test of problem-solving abilities, there will be significant differences between more experienced and less experienced officers. Experienced officers will have more domain-relevant tacit knowledge, and will therefore be able to draw more readily on this knowledge to answer questions on a practical leadership-related problem. More experienced officers will be

able rationalize and justify their responses, in contrast to the less experienced officers. As noted by Klein (1995), it is possible to probe experienced individuals for the alternative courses of action they would take to solve a practical problem. Experienced individuals can note the advantages and disadvantages of those courses of action. Furthermore, experienced officers should be able to reflect more readily on their metacognitive problem-solving strategies, and this reflection should aid in providing a complete and accurate answer. Thus, to the extent that practical intelligence is a form of developing expertise, significant differences should be evident in the way more experienced and less experienced officers solve practical problems.

Also, officers who score well on the metacognitive problem-solving strategies should also score well on the tacit-knowledge scenarios. This relation should occur because metacognitive problem-solving ability should be accompanied by more sophisticated and useful tacit knowledge. Officers with a high degree of tacit knowledge should be able to draw on their metacognitive problem-solving strategies in rating tacit-knowledge response options, as they do in solving everyday practical problems or hypothetical situations. Also, as demonstrated in our model of practical intelligence and tacit-knowledge acquisition, tacit knowledge is a subcomponent of, and related to, the metacognitive processes. Because tacit knowledge is the product of metacognitive skill, officers with high-tacit knowledge scores should also display better metacognitive problem-solving strategies.

Method

In order to further our understanding of tacit knowledge, we sought to identify the processes associated with metacognitive problem-solving ability that underlie tacit-knowledge acquisition. Although the existing TKML measures provide a useful tool for assessing existing knowledge, they provide limited insight into the ways individuals process information and deal with practical problem situations (e.g., how they define the problem, how they use information, how they derive and monitor a solution). Existing approaches to studying leadership—including our own—primarily use quantitative approaches that fail to capture important contextual information (Bass, 1990; Blair & Hunt, 1985; Conger, 1998; Isenberg, 1985; Yukl, 1998). Furthermore, as noted by Means et al. (1995), real-world tasks are generally quite complex and "may have multiple goals . . . which may or may not be mutually compatible" (p. 313). Real situations typically have dilemmas—choosing one avenue may have certain positive effects for one part of the problem, but may also have deleterious effects for another.

We chose to develop a measure that would present multiple problems so that actual conditions could be simulated more closely than the situational-judgment tests used in our TKML instruments. Consequently, we constructed extensive case studies so that we could better assess problem-solving ability. In developing a measure of the tacit-knowledge acquisition processes, we aimed to provide enough detail to allow officers to respond effectively to the problem, and to present a difficult enough situation in which to observe individual differences in knowledge-acquisition and problem-solving skills. The approach we decided to pursue draws on two methods commonly used in managerial assessment and education: in-basket tests and case study problems.

In an in-basket test, individuals are given various documents that they might find in an in-basket, and are required to sort through, prioritize, and respond to those documents. Individuals

are assessed on how well they prioritize the documents, and how appropriately they respond to them. Case studies provide detailed descriptions of a situation, often including information on the action taken and the outcome. Case studies are often used as teaching tools in which students are asked to evaluate how the problem was solved, and to suggest alternative approaches. Our goal was to not only assess how well an individual evaluates a problem solution, but also to assess how they define the problem and generate possible solutions. In other words, we wanted to provide individuals with information pertaining to a situation, and then assess how they use that information to develop a solution. Therefore, we combined the case study and in-basket formats to develop detailed case scenario problems.

The case scenarios consist of a brief summary of a situation along with supporting documents such as memos, personnel files, reporting procedures, activity logs, and so forth that pertain to the situation (refer to Appendix B for the Platoon Scenario, and Appendix C for the Company Scenario). These documents are fictitious, but are designed to be representative of practical problems that leaders might encounter on the job. Our intent was to represent a situation in a form that could be used to elicit a thoughtful, written response from participants. We developed problem scenarios based on stories collected during interviews with Army leaders, and subsequent tacit-knowledge items developed from those stories (see Horvath, Forsythe, et al., 1994). First, we identified several tacit knowledge items that we considered promising for scenario development. These items reflected a specific situation, and included enough detail in the original story on which to build a more elaborate scenario. Next, we examined open-ended responses collected on the tacit-knowledge scenarios during an earlier phase of this research (see Hedlund et al., 2000). Based on our analysis of those responses, we identified tacit knowledge items that appeared to meet three criteria. We selected items that (a) presented a complex situation involving multiple problem dimensions, (b) stimulated a variety of different interpretations of the problem situation, and (c) resulted in more than one appropriate response. Finally, for those items selected, we outlined a set of additional issues and materials (e.g., performance evaluations, training schedules, etc.) that we felt should be incorporated into the scenario descriptions in order to create detailed case scenario problems. We relied on the original stories as well as officers' written responses to identify those issues and materials. The stories are listed in Appendixes D and E, and will serve as the basis for the next phase of our efforts to develop a tacit-knowledge acquisition inventory. For this study, we focused solely on the platoon and company levels, because these new instruments would be intended for use in the assessment and development of platoon leaders and company commanders.

In developing the current case-study scenarios, we chose to incorporate aspects of different stories in order to enhance the complexity and multidimensionality of each individual scenario. Platoon Scenario 1 (PS1) draws on stories 2 and 3 of Appendix D. Company Scenario 1 (CS1) draws on stories 2 and 3 of Appendix E. We used the stories to create summary descriptions of the problem. Then, we identified a list of potential materials that could be used to present or expand upon information described in the scenario. For example, in CS1 we chose to present information on the background of the transferred leader in the form of Officer Evaluation Reports (OERs). In PS1, we chose to include media on Army retention rates to bring the issue of soldier retention into the scenario. We identified all materials through manual and electronic searches of Army documents, such as Field Manual 22-100 (U.S. Department of Army, 1999), and websites (e.g., http://www.dtic.mil/armylink/news). The scenarios underwent several

iterations, and were reviewed for basic coherency by a battalion executive officer and a battalion commander. The final draft items were revised for minor issues based on feedback from an initial administration to a group of Lieutenant Colonels.

As noted in Appendixes B and C, each scenario is followed by nine questions intended to assess the componential subtheory of Sternberg (1985, 1988, 1997), that is, the knowledge-acquisition components, the metacomponents, and the performance components. These nine questions should approximate the cognitive processes underlying our model of practical intelligence and tacit-knowledge acquisition. The questions were also designed to tap into the feedback loops of individuals by asking them to justify their choices, and to project possible outcomes and obstacles to their implementation. By asking specific open-ended questions, we attempted to identify more readily, each process that we wished to assess. Simply asking officers what they would do in a particular situation typically results in a very limited response, as we found in our pilot results. Furthermore, we sought to evaluate the officers' problem-solving processes based on how effectively they answered the questions as compared to an expert profile. Because ill-structured tasks "typically have several equally good ways of solving the same problem" (Orasanu & Connolly, 1995, p. 8), we allowed officers to answer freely on the nine problem-solving questions. We operated under the assumption that producing a solution to a problem is more difficult—and more realistic—than simply rating possible solutions that have been provided. Furthermore, we assumed that generating a solution to a problem, predicting the consequences of the solution, and monitoring the outcomes of the solution taps into the higher-order thinking processes outlined in the triarchic theory. We cannot make a similar statement for our existing TKML scenarios because they are mere markers of the tacit knowledge that individuals may possess. We believe, though, that the two approaches should share variance, given the close association between tacit knowledge and metacognitive problem-solving ability.

Results

PS1 Case Study

Participants who completed the Platoon Scenario 1 (PS1) included 18 Lieutenants, 17 Captains, 15 Majors, and 4 Lieutenant Colonels. These officers also completed four TKML scenarios relative to their rank. In order to evaluate the quality of the PS1 responses given by officers, it was first necessary to create a profile of expert responses. This profile was created by using the responses of a set of 15 experienced officers (9 Lieutenant Colonels, and 6 Majors). For each question, we coded all given responses and their frequencies. For example, the first question asked officers to identify the main problem. Experts gave responses such as "The captain gave a bad order" (frequency = 7), which accounted for 21% of total responses for that question, and "The soldier is being insubordinate; the problem is a lack of discipline" (frequency = 20), which accounted for 59% of total responses. All possible responses were recorded—including multiple responses of some officers—and their frequencies tallied as a percentage of total frequencies for that question. This procedure was repeated for all nine questions. Coded responses and their frequencies were used for the nonparametric analysis. The frequency percentage data were log-transformed to enable the use of parametric analysis.

To create the expert profile, two of the authors of this report created categories of expert responses, and reached full agreement. The set of expert response categories and their frequencies were used as a scoring schema from which we rated officer responses. The answers of officers who gave responses that fit a category on the expert profile were coded according to the relevant expert category of responses (for the nonparametric tests), and also given a score equal to the frequency percentage of that category (for the parametric tests) representing the percentage of experts who gave the same response. If an officer's answer did not correspond to any of the expert categories, or if the officer did not indicate an answer to a particular item, that item was coded into a separate category (representing a wrong, or no answer) for the nonparametric analysis, or scored as a zero for the parametric analysis. A sample of officer responses was used to test the rating protocol and the interrater agreement. Initially, the raters agreed on 82% of the responses scored for the case study, representing 81 out of a possible 99 agreements. After correcting for rater error, and lack of clarity in the protocol, the agreement rate improved to 96%, representing 95 out of a possible 99 agreements. The two raters then scored the rest of the officers according to this revised coding scheme.

The procedure for constructing the expert officer profile revealed a consistent pattern of responses among the experts for the questions. This pattern of responses can be summarized as follows:
1. The main problem (Question 1a) is one of lack of discipline.
2. Lack of discipline is a problem (Question 1b) because it affects performance (e.g., in the upcoming platoon exercise, or in the future battlefield).
3. The appropriate course of action (Question 2a) in such a situation is to punish the insubordinate soldier.
4. The course of action is appropriate (Question 2b) in order to maintain discipline.
5. The relevant information used to solve this problem (Question 3a) was the paperwork that indicated that insubordination was a recurrent problem with Jones (the insubordinate soldier).
6. The assumptions that were made (Question 3b) varied.
7. Most experts would have sought additional information (Question 3c) on Jones's background and behavior.
8. The experts' expected outcome (Question 4a) was that discipline would be maintained, and the attitude of Jones would improve.
9. The obstacles (Question 4b) to this outcome were Jones' continued insubordinate attitude and behavior.

The fact that there was a great deal of consensus among the experts suggested that our solution schema was relatively reliable and valid. Only one item (Question 3b: What assumptions did you make about the problem?) failed to yield a consensus among the experts. This lack of consensus may be attributed to the possibility that individuals make many assumptions in seeking a solution to a problem, and that these assumptions may be difficult to articulate.

Once the expert profile was completed, and the officers' answers coded, we conducted multisample (multifrequency) chi-square analyses on the frequency distributions to discern group differences on the metacognitive problem-solving strategies. Due to the low number of

Lieutenant Colonels in the sample, we included them in the group of Majors for all analyses. Summary responses for the differences between Majors and Experts, Captains and Experts, and Lieutenants and Experts are reported in Tables 6, 7 and 8 respectively.

Table 6
Chi-Square Differences of Majors and Experts

Response category	Total responses	$\underline{df}$	χ^2	$\underline{p}$
1a-Problem definition	57	6	2.80	.83
1b-Problem rationale	44	6	11.07	.09
2a-Proposed solution	71	9	3.18	.96
2b-Solution rationale	43	4	13.79	.01
3a-Relevant information	40	6	12.02	.06
3b-Assumptions	38	15	28.67	.02
3c-Information sought	38	6	15.11	.02
4a-Expected outcome	62	8	5.66	.69
4b-Expeected obstacles	42	9	12.20	.20

Note: Total responses differed by response category as some officers generated multiple answers. Majors ($\underline{n}$ = 16) and Experts ($\underline{n}$ = 15) (Four Lieutenant Colonels were included in the group of Majors due to insufficient representation).

H4$_a$, which stated that less experienced officers would exhibit significantly different metacognitive problem-solving abilities as compared to more experienced officers, was supported. The patterns of responses suggested that when compared to the expert profile, less experienced officers had more discrepant responses than more experienced officers. Majors exhibited statistically significant differences on only three items, namely, 2b (solution rationale), 3b (assumptions), and 3c (information sought). Refer to Table 6 for complete results.

Captains exhibited significant differences on four items, including items 2b (solution rationale), 3a (relevant information), 3b (assumptions), and 3c (information sought). Refer to Table 7 for complete results.

Lieutenants exhibited the greatest number of statistically different responses, including items 1b (problem rationale), 2b (solution rationale), 3b (assumptions), and 3c (information sought), 4a (expected outcome), and 4b (expected obstacles). Refer to Table 8 for complete results.

This particular scenario required participants to consider their actions at the level of Lieutenant, the lowest rank represented in our sample. Consequently, officers above the level of Lieutenant have a higher degree of expertise in such a scenario, because they were promoted from the rank of Lieutenant based on various performance-related criteria. Therefore, responses from Lieutenants were examined in relation to each of the other groups of officers with the expectation that responses would differ. As would be expected, the Lieutenants responded differently from the more experienced officers. Compared to the Captains, these Lieutenants differed on items 1b ($\chi^2(12, \underline{n} = 62) = 25.57$, $\underline{p} < .05$), 2b ($\chi^2(8, \underline{n} = 59) = 22.10$, $\underline{p} < .01$), and 3c

$(\chi^2(12, \underline{n} = 53) = 26.56, \underline{p} <. 05)$. When comparing the Lieutenants to the Majors, significantly different responses were found on these same items: 1b $(\chi^2(12, \underline{n} = 62) = 24.24, \underline{p} < .05)$, 2b $(\chi^2(8, \underline{n} = 61) = 20.67, \underline{p} < .01)$, and 3c $(\chi^2(12, \underline{n} = 56) = 24.77, \underline{p} <. 05)$. Captains and Majors only had two significant differences on the following items: 2b $(\chi^2(8, \underline{n} = 60) = 17.27, \underline{p} < .05)$, and 3c $(\chi^2(12, \underline{n} = 55) = 21.72, \underline{p} < .05)$. As is evident, the differences in response categories between Lieutenants and Majors, and Lieutenants and Captains were less than the differences between Lieutenants and Experts, and differences between Captains and Majors were the smallest.

Table 7
Chi-Square Differences of Captains and Experts

Response category	Total responses	$\underline{df}$	χ^2	$\underline{p}$
1a-Problem definition	51	6	6.65	.35
1b-Problem rationale	44	6	8.57	.20
2a-Proposed solution	67	9	4.85	.85
2b-Solution rationale	41	4	11.40	.02
3a-Relevant information	39	6	13.90	.03
3b-Assumptions	37	15	28.99	.02
3c-Information sought	35	6	16.72	.01
4a-Expected outcome	61	8	4.42	.82
4b-Expeected obstacles	41	9	14.72	.10

Note: Total responses differed by response category as some officers generated multiple answers. Captains ($\underline{n}$ = 16) and Experts ($\underline{n}$ = 15).

Table 8
Chi-Square Differences of Lieutenants and Experts

Response category	Total responses	$\underline{df}$	χ^2	$\underline{p}$
1a-Problem definition	54	6	7.97	.24
1b-Problem rationale	42	6	21.26	.00
2a-Proposed solution	66	9	13.93	.13
2b-Solution rationale	42	4	18.85	.00
3a-Relevant information	41	6	10.00	.12
3b-Assumptions	37	15	27.66	.02
3c-Information sought	36	6	19.91	.00
4a-Expected outcome	56	8	16.36	.04
4b-Expeected obstacles	42	9	20.05	.02

Note: Total responses differed by response category as some officers generated multiple answers. Lieutenants ($\underline{n}$ = 18) and Experts ($\underline{n}$ = 15).

In order to use parametric tests on these data and discern the direction of these differences, frequency scores were transformed to better approximate a normal distribution and to enable the calculation of a linear composite of the metacomponential indicators. According to Hair, Anderson, Tatham and Black (1998), for the purposes of analysis, nonlinear data can be transformed to linear data by using a logarithmic transformation.

We created a "metacognitive problem-solving score" (hereafter referred to as the linear composite) using the linear composites of the nine items. The linear composite was created by summing the log-transformed frequency data of the nine items for each officer. The alpha reliability coefficient of this scale was .68. Our alpha was within the range of .50 to .80 for situational judgments tests, which, according to Legree (1995), are extremely complex and whose depicted problems are poorly defined, thus allowing for a lower alpha value as compared to standardized response-option tests. The means and intercorrelations of the transformed variables and the linear composite are reported in Table 9.

As is evident in Table 9, the part-whole correlations indicated that each item shared sufficient variance with the composite to be included in the composite. Similar to Marshall-Mies et al. (2000), the correlations between the various metacognitive items were low to modest. These correlations suggested that the measures are somewhat independent of each other but, as indicated by the part-whole correlations and the alpha value, relate sufficiently enough to each other to represent an overarching measure of metacognitive problem-solving ability. Furthermore, the variability in the measures suggested that they were tapping individual differences in responses. Interestingly, problem definition and problem rationale were significantly correlated, $r(54) = .38$, $p < .01$, as was the proposed solution with the solution rationale, $r(54) = .43$, $p < .01$. Similarly, the expected outcomes correlated significantly with the expected obstacles, $r(54) = .29$, $p < .01$. These patterns of correlations provided some support for our theoretical constructs relating to the problem, the solution, and the outcome.

In this section of the analysis, we sought to determine whether scores on the metacognitive composite measures differed between more experienced and less experienced officers. For the purpose of this analysis, we included Captains and Majors in the experienced officer group, and Lieutenants in the less-experienced group. As mentioned previously, in this scenario only Lieutenants can be considered as less experienced, and all other officers who have been promoted above the rank of Lieutenant can be considered as experienced. All other officers (Captains and Majors) presumably have more experience with the type of situation depicted in the scenario. Also as corroborated in the multisample chi-squared results, only two differences (from nine items) were evident between Captains and Majors.

Table 9

Means and Intercorrelations of Metacognitive Items and Composites

Variables	M	SD	1	2	3	4	5	6	7	8	9
1. Prob. definition	3.25	1.32									
2. Prob. rationale	2.10	1.64	.38**								
3. Proposed solution	2.63	1.20	.26	.07							
4. Solution rationale	2.21	1.99	.34*	.26	.43**						
5. Relevant info.	2.29	1.74	.28*	.19	.15	-.02					
6. Assumptions	.44	.80	.20	.33*	-.04	.33*	-.02				
7. Info. sought	1.63	1.76	.00	.16	.16	.22	.15	.08			
8. Expected outcome	2.70	1.19	.16	.23	.32*	.22	.35**	.15	.21		
9. Expected obstacles	1.55	1.69	.00	.26	.18	.23	.30*	.23	.27	.29*	
10. Linear composite	18.80	7.29	.52**	.59**	.51**	.63**	.51**	.40**	.50**	.58**	.59**
11. Part-whole[1]			.37**	.41**	.37**	.42**	.30**	.30**	.29*	.45**	.41**

Note: [1]Item total correlation of composite, less item that is being correlated to the composite; total n = 54; composite alpha reliability = .68.

*p < .05; **p < .01.

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Item and composite means for the two groups are reported in Table 10. As noted from the results, the experienced officers consistently scored higher than the Lieutenants on all items, and on the composites. The Lieutenants (M = 15.90, SD = 7.31) had significantly lower total metacognitive composite scores than the experienced officers (M = 20.24, SD = 6.93), $\underline{t}(52) = $ -2.13, $\underline{p} < .05$. This difference could not be traced to any particular item (Greenhouse Geisser within-subjects interaction effect: $\underline{F}(6.08, 316.27) = .51$, ns). The differences between the Lieutenants and the experienced officers provided further support for *H4$_a$*, because higher scores on the metacognitive measures indicated closer agreement with the most frequently generated response options of the experts.

TABLE 10
Means of Experienced Officers and Lieutenants on Metacognitive Items and Composites

Response category	Experience officers ($\underline{n}$ = 26)		Lieutenants ($\underline{n}$ = 18)	
	$\underline{M}$	$\underline{SD}$	$\underline{M}$	$\underline{SD}$
1a-Problem definition	3.32	1.17	3.10	1.60
1b-Problem rationale	2.40	1.52	1.50	1.75
2a-Proposed solution	2.74	1.00	2.41	1.54
2b-Solution rationale	2.43	1.94	1.78	2.07
3a-Relevant information	2.36	1.77	2.16	1.74
3b-Assumptions	.45	.81	.41	.80
3c-Information sought	1.86	1.75	1.16	1.72
4a-Expected outcome	2.90	.97	2.30	1.50
4b-Expeected obstacles	1.79	1.78	1.09	1.43
Composite	20.24	6.93	15.90	7.31

Because Lieutenants scored poorly on the linear composites, we examined the degree to which they were able to provide a response to the nine questions. In other words, we sought to examine whether the length of responses differed between the more experience and less experienced officers. Although length of response is a crude measure, the quality of the responses was already captured in the ratings of responses. We conducted an ANOVA to test group differences on length of responses, and found that Lieutenants (M = 37.03, SD = 15.83) used significantly fewer words than the experienced officers (M = 46.75, SD = 17.00), $\underline{F}(1,52) = 4.10$, $\underline{p} < .05$. This result suggested that Lieutenants did not have the domain relevant knowledge to answer some of the questions.

H4$_b$, which stated that metacognitive problem-solving scores of officers would be related to their tacit-knowledge scores, was partially supported. The metacognitive problem-solving scores (i.e., the linear composites) and the tacit-knowledge scores of officers attempt to tap tacit knowledge but they differ in the amount of information presented to, and requested of, participants. For example, in the TKML, participants were given a brief description of a problem scenario and asked to rate a series of solution options. However, in the PS1, officers were given a detailed description of the problem

scenario along with accompanying materials that may or may not have aided in decision-making. The officers were required to articulate their own solutions to the problems along with justifications. Thus, the TKML and the PS1 attempt to measure a similar construct (tacit knowledge) in different ways. As noted previously, though, the PS1 goes beyond mere tacit knowledge, and includes the metacognitive problem-solving ability underlying the acquisition and application of tacit knowledge.

In order to use the frequency data for this analysis, officers were split into high and low tacit-knowledge groups based on their TKML scores. In these analyses, the TKML inventory was not related to scores on any of the individual extended scenario items for all officers, nor when officers were divided by ranks.

Across all participants, metacognitive scores were significantly correlated with TKML scores, $r(50) = .33$, $p < .05$. When corrected for attenuation, the correlation coefficient increased to .40. We considered the possibility that the TKML and linear composites would yield a higher correlation depending on the officers' level of expertise in the domain. Looking at total scores, the linear composites were not significantly correlated with tacit-knowledge scores of lieutenants ($r(18) = .26$, ns; $r = .31$ when corrected for attenuation), nor of experienced officers ($r(32) = .28$, ns; $r = .34$ when corrected for attenuation).

CS1 Case Study

Participants who completed the Company Scenario 1 (CS1) included 6 Lieutenants and 19 Captains. The expert profile was created from the responses of 20 experienced officers (13 Lieutenant Colonels, and 7 Majors). Interrater reliability was initially 73% (85 out of a total of 117 agreements), which then improved to 95% (111 out of 117 agreements) after resolving for rater error and lack of clarity in the rating protocol. The patterns of responses of the experts can be summarized as follows:
1. The main problem (Question 1a) was which platoon to send for the cross-attachment.
2. Which platoon to send is a problem (Question 1b), because the commander asked the Captain to "make or break" Marx (by keeping Marx, the Captain may hurt his own performance at NTC, by sending Marx, he fails to develop Marx).
3. The appropriate course of action (Question 2a) is to keep Marx and send the best platoon for the cross-attachment.
4. The decision to keep Marx (Question 2b) was because the Captain was asked by the commander to develop Marx.
5. The relevant information used to solve this problem (Question 3a) was the background on Marx's poor performance
6. The assumptions that were made (Question 3b) varied (as with the PS1).
7. Most experts would have sought additional information (Question 3c) on Marx to observe why he was not performing well.
8. The experts' expected outcome (Question 4a) was that Marx's tactical skills would improve, and that there would be a successful cross-attachment.
9. The obstacles (Question 4b) to this outcome were Marx's abilities, and possible lack of time on the part of the Captain to develop Marx.

Due to the small sample size ($\underline{n}$ = 25), and the unbalanced groups (6 Lieutenants, and 19 Captains) of respondents, further analyses could not conducted. As an indicator of the validity of the instrument, we can report that the mean on the composite measure of the Lieutenants was 13.76 (SD = 6.37), and that of the Captains was 17.91 (SD = 4.70). The difference between the groups was not significant, $\underline{t}$(23) = -1.61, ns, which is not surprising, given the small sample size and the unbalanced groups (Kraemer & Thiemann, 1987). Because the mean of the Captains is substantially higher than that of the Lieutenants, the results appear to be promising. Furthermore, our sample sizes will be increased as we intend to use this instrument at future umbrella weeks under the auspices of another ARI-sponsored grant, which should increase the power of the test to detect the effect.

Discussion

Confirming our theoretical propositions, the results concerning the case studies suggest that more and less-experienced officers can be distinguished based on their metacognitive problem-solving abilities and their underlying tacit knowledge. In other words, differences between the officers were evident regarding how problems were identified, solution strategies formulated, information about the problem represented, and outcomes of their solution assessed.

We proposed that more experienced officers have more knowledge, should be able to more readily articulate this knowledge, and should be able to regulate their problem-solving strategies more effectively than less experienced officers. These differences were evident in the nonparametric tests, where we found a greater number of significant differences between experts and Lieutenants, as compared to experts and Majors or Captains. As regards the parametric procedures, we found a significant difference on the composites of the metacognitive measures when comparing the Lieutenants to the experienced officers.

We examined the responses of Lieutenants to understand how they diagnosed and solved the problem, because their response profile was generally incongruent to that of the experts. Recall that the Lieutenants differed on six of nine metacognitive measures. Where significant differences occurred, the data indicated that the Lieutenants tended to (a) either respond with an answer that failed to address the question, or (b) failed to respond. Specifically, most Lieutenants identified the problem as a lack of discipline, but the majority were unable to state why this was the main problem. Those who did offer a justification gave the "expert" response equally as often as one that did not fit the category of the expert response. The second question was also answered correctly: Lieutenants suggested that the best course of action would be to punish the insubordinate soldier, but again, they did not know why this would be the best course of action. Lieutenants gave the expert response, or no response equally often. The majority of Lieutenants agreed with the experts that Jones's history of insubordination was the key piece of relevant information in the scenario. Like experts, Lieutenants did not reach consensus regarding the assumptions underlying their solution to the problem, and this distribution was significantly different from that of the experts. Lieutenants' responses

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regarding the information they would seek to help solve the problem did not match the expert's responses, and the majority of Lieutenants were unable to answer that question at all. Most Lieutenants agreed with a popular expert opinion in their outcome assessment (Jones' attitude changes), although this response was not the most frequent response among experts who stated that discipline would be maintained. Last, Lieutenants were generally unable to name any obstacles to attaining this outcome.

Given these differences between expert officers and Lieutenants, it appears that Lieutenants are more likely to have incorrect answers, or else to give no answer when tacit knowledge and metacognitive strategies are to be articulated. It is possible that Lieutenants simply do not have enough experience to have acquired the tacit knowledge needed to answer these meta-level questions. Furthermore, the Lieutenants' cognitive problem-solving abilities may be less developed than those of the experienced officers, presumably because Lieutenants lack experience. As the theory predicts, experienced officers may be able to answer these questions more accurately due to their experience and greater amount of opportunities for reflection. The performance of experienced officers may be attributed to more effective metacognitive problem-solving strategies that allows them to draw more effectively on their existing knowledge, and modify their strategies as necessary to solve practical problems. Overall, these results provide support for our model of practical intelligence and tacit-knowledge acquisition.

The relationship between the linear composite measure of metacognitive knowledge and the TKML measure is interesting. Although the two measures share about 16% common variance (as indicated by the correlation of the TKML scores with the PS1 composite), they clearly are not measuring the same factors. The TKML is more focused on the ratings of response options, while the PS1 and CS1 go beyond mere knowing of a solution, to monitoring the variables that govern tacit-knowledge acquisition and application. Whereas the TKML simply asks participants to rate series of options in response to a briefly-described scenario, the case studies require participants to read a relatively large amount of information, sift through it for relevancy, and reflectively offer their own responses to the questions asked. As regards our model of practical intelligence and tacit-knowledge acquisition presented in Figure 1, the PS1 and CS1 scenarios appear to address all of the components in depth, while the TKML only deals with the components in a cursory manner. Naturally, the task of devising one's own solution to a problem is quite different from that of recognizing a good solution from a list of options. In examining Klein's recognition-primed decision model, Lipshitz (1995) noted that "contrary to the traditional definition of *decision making* as choosing alternatives, proficient decision makers rarely compare among alternatives. Instead they assess the nature of the situation and, based on this assessment, select an action appropriate to it" (p. 107). Because the case studies allow officers to assess the nature of the situation, and to generate their own actions to solving the problem, we believe that these measures may be more realistic in terms of what they test, and that they may be more predictive of leadership effectiveness than the TKML. This proposition will require further empirical testing.

Study 3—Facilitating Tacit-Knowledge Acquisition

Hypothesis

H5 The tacit-knowledge scores of officers will improve after a facilitated group discussion.

As noted previously, officers should be able to learn vicariously from one another. We predicted that this vicarious learning could be simulated in a facilitated group discussion whose effect would be evident when comparing officers' pre-discussion scores to their post-discussion scores.

Method

To test the efficacy of a potential intervention to facilitate tacit-knowledge acquisition, officers completed pre- and post-measures of the rank-appropriate TKML scenarios at two sites. Our sample consisted of Lieutenants (n = 22), who completed four PLQ scenarios, Captains (n = 23), who completed four CCQ scenarios, Majors (n = 23), who completed four BCQ scenarios, and Lieutenant Colonels (n = 10), who completed four BCQ scenarios. We wanted to focus initially on those scenarios that were likely to promote the most discussion and interest from leaders. We looked at the amount of variability exhibited in the ratings of response alternatives for the scenario, the extent to which the scenario prompted different interpretations and problem solutions, and the leadership dimensions represented by the scenarios. In taking into account all of these factors, we decided to focus our efforts initially on the following scenarios:

1. Battalion Commander Questionnaire Scenario B1—developing subordinates, B3—protecting the organization, B12—communicating, B13—dealing with poor performers.
2. Company Commander Questionnaire Scenario C1—taking care of soldiers, C4—establishing trust, C5—managing oneself, C10—motivating subordinates.
3. Platoon Leader Questionnaire Scenario P3—influencing the boss, P9—motivating subordinates, P7—establishing credibility, P15—managing oneself.

The interventions were administered to the four officer groups (i.e., Lieutenants, Captains, Majors, and Lieutenant Colonels) separately. For the pre-test, we first distributed the scenarios to the officers, who we asked to rate the various response options. We then allowed officers to discuss freely the scenarios and the response options, to share their experiences with the other officers, and to discuss what they thought would be the best course of action to implement. We intervened in the discussion to refocus it when appropriate, using the expert results as guidelines. We also intervened to "prompt" officers to state their assumptions, rationale, or any other implicit knowledge. After it appeared that some form of consensus was reached among the officers, we readministered the scenario (i.e., the post-test). We expressly asked the officers not to refer to their pre-test questionnaire. The discussions ranged between 15 to 25 minutes per scenario.

We used two different analysis methods to determine whether the intervention had any effect. In the first method, we compared the mean correlation of the officers with the experts before the intervention, with the mean correlation of the officers with the experts after the intervention. All analyses using correlation coefficients as variables were conducted on the z' transformed values. We used a t-test for matched groups to determine if the effect was significant. Thus, the expert means served as a control for this method. In the second method, we used ANOVA repeated-measures analyses by comparing the officer's pre- and post-ratings across each item to determine if the ratings changed significantly over time. Thus, the individual officers served as their own controls in these analyses.

H5, which stated that the tacit-knowledge scores of officers would improve after a facilitated group discussion, was partially supported. As the results in Table 11 indicate, across all four items of the respective rank-level test, only the post-correlation means of the Captains, who completed the CCQ, improved significantly. The mean scores of the Lieutenants decreased, but this result was not significant. The mean scores of the Majors and Lieutenant Colonels who completed the BCQ remained unchanged.

We conducted the same procedure on the four TKML items of the PLQ, CCQ, and BCQ to determine how the mean correlations of those items were affected by the intervention. Results of this analysis are reported in Tables 12, 13, and 14 respectively. Results from the PLQ indicated that the changes that occurred were contrary to the hypothesized direction. The mean correlations of two items decreased significantly (Items 3 & 15). The mean correlations of two items (7 & 9) increased slightly, but this difference was not significant.

Table 11
Pre- and Post-Correlations of TKML Measures

TKML measure	Pre-correlation			Post-correlation			df	t
	mean r to z	SD	z to r	Mean r to z	SD	z to r		
PLQ 4 items	.67	.25	.58	.64	.21	.57	21	.95
CCQ 4 items	1.02	.22	.77	1.15	.22	.82	22	2.95**
BCQ 4 items	.90	.22	.72	.90	.14	.72	32	.16

Note: PLQ = Platoon Leader Questionnaire; CCQ = Company Commander Questionnaire; BCQ = Battalion Commander Questionnaire. BCQ n = 33; CCQ n = 23; PLQ n = 22. **p < .01

The results of the CCQ indicated that only the mean correlation of Item 1 increased significantly. The rest of the correlations did not change significantly; the mean correlations of Items 4 and 10 changed in the hypothesized direction, while the mean correlation of Item 5 decreased slightly.

Table 12
Pre- and Post-Correlations of PLQ Measures

TKML measure	Pre-correlation			Post-correlation			df	t
	mean r to z	SD	z to r	mean r to z	SD	z to r		
PLQ 3	.76	.48	.64	.57	.36	.52	21	2.65*
PLQ 7	1.26	.60	.85	1.36	.88	.87	21	.90
PLQ 9	.79	.36	.66	.81	.67	.67	21	.23
PLQ 15	.43	.41	.41	.27	.30	.26	20	2.40*

Note: PLQ = Platoon Leader Questionnaire. *p < .05

Table 13
Pre- and Post-Correlations of CCQ Measures

TKML measure	Pre-correlation			Post-correlation			df	t
	mean r to z	SD	z to r	mean r to z	SD	z to r		
CCQ 1	.83	.32	.68	1.03	.21	.77	22	2.78*
CCQ 4	1.10	.45	.80	1.13	.38	.81	22	.23
CCQ 5	1.58	.78	.92	1.46	.66	.90	22	.97
CCQ 10	1.58	.54	.92	1.69	.53	.93	22	.96

Note: CCQ = Company Commander Questionnaire. *p < .05

As indicated by the results in Table 14, the mean correlation of BCQ Item 12 decreased significantly, while the mean correlation of Item 13 increased significantly. The mean correlation of Item 1 increased slightly, and the mean correlation of Item 3 decreased slightly. The mean differences in correlations for Item 1 and 2 were not significant.

Next, we tested the extent to which the mean pre-test correlation of the individual officers with the experts differed significantly from the mean post-test correlation of the individual officers with the experts. We used the t statistic for testing the difference between r_{xy} and r_{vy} (Cohen & Cohen, 1983, p. 57). A summary of the results of this analysis is reported in Table 15.

Table 14
Pre- and Post-Correlations of BCQ Measures

TKML measure	Pre-correlation			Post-correlation			df	t
	mean r to z	SD	z to r	mean r to z	SD	z to r		
BCQ 1	.92	.31	.73	.94	.26	.74	32	.39
BCQ 3	.98	.43	.75	.96	.39	.74	31	.29
BCQ 12	.65	.48	.57	.52	.46	.47	32	2.34*
BCQ 13	.84	.39	.69	.91	.36	.72	32	2.26*

Note: BCQ = Battalion Commander Questionnaire
*p < .05

Table 15
Summary of Significant Increases and Decreases of Officer Scores on TKML Measures

TKML measure	N	Score increase*	Score decrease*	No difference
BCQ	33	5	6	22
CCQ	23	6	1	16
PLQ	22	1	3	18
Total	78	12	10	56

Note: *p < .05 (one-tailed).

Thus, it appears that whatever significant differences did occur, were accounted for by a small number of individuals. Furthermore, changes that occurred were accounted for by only 2 items on the PLQ, 1 item on the CCQ, and 2 items on the BCQ. Some of the changes were in the hypothesized direction, while others were not.

We then used ANOVA repeated-measures analysis to determine whether officers' pre- and post-ratings across response options on the TKML changed significantly. To test for the magnitude of effect, we report η^2 and ω^2 (Howell, 1997). Howell stated that measures of effect represent the percentage of variation in the dependent measure that is accounted for by the effect. Howell noted that η^2 is biased upward and generally useful for testing effects in populations. For samples, Howell stated that ω^2 provides a better measure of effect and corrects for error bias. For purposes of comparison we reported both η^2 and ω^2. Mauchly's test for sphericity for the repeated measures—a measure of whether differences in pairs of scores vary equally—indicated no violations. Thus, the F statistics of the univariate test are reported as recommended by Girden (1992). The results of the repeated measures across all items are reported in Table 16.

The interaction of time and response items appeared to have a significant effect in all three groups. The magnitude of the effect, though, was small. At most—and with the liberal measure (η^2)—only 10% of the variation in the scores could be accounted for by the time-response item effect. The conservative measure (ω^2) indicated that at best 2% of the variation in the scores could be accounted for by the time-response item effect.

We then sought to determine how the scores on each of the response items reacted to the intervention. Those results are reported in Tables 17, 18, and 19. For the PLQ, significant time-response item interactions were evident for Items 3, 7, and 9. The magnitude of the effect was again small, with a maximum of 12% of the variation accounted for by the effect based on the liberal measure, and a maximum of 2% of the variation accounted for by the effect based on the conservative measure. Refer to Table 17 for the results.

Table 16
Repeated Measures ANOVA of Pre- and Post-Scores on BCQ, CCQ, and PLQ

Source	df	F	η^2	ω^2
BCQ 4 Scenarios; 45 questions; n = 33				
Time	1	.04	.00	.00
Response Items	44	3.58**	.13	.11
Time x Response Item	44	1.80**	.07	.01
CCQ 4 Scenarios; 38 questions; n = 23				
Time	1	4.93*	.19	.00
Response Items	37	2.72**	.12	.08
Time x Response Item	37	1.61*	.07	.02
PLQ 4 Scenarios; 40 questions; n = 22				
Time	1	.45	.03	.00
Response Items	39	5.16**	.26	.21
Time x Response Item	39	1.63*	.10	.01

Note: PLQ = Platoon Leader Questionnaire; CCQ = Company Commander Questionnaire; BCQ = Battalion Commander Questionnaire. *p < .05; **p < .01.

Table 17
Repeated Measures ANOVA of Pre- and Post-PLQ Scores

Source	df	F	η^2	ω^2
PLQ Scenario 3; 11 questions				
Time	1	1.59	.07	.00
Response Items	10	6.76**	.25	.19
Time x Response Item	10	2.82**	.12	.02
PLQ Scenario 7; 10 questions				
Time	1	.85	.04	.00
Response Items	9	2.43*	.11	.08
Time x Response Item	9	2.64**	.12	.02
PLQ Scenario 9; 7 questions				
Time	1	.31	.02	.00
Response Items	6	5.66*	.21	.11
Time x Response Item	6	2.42*	.10	.01
PLQ Scenario 15; 12 questions				
Time	1	1.20	.07	.00
Question	11	6.46**	.28	.23
Time x Question	11	1.74	.09	.01

Note: PLQ = Platoon Leader Questionnaire; Note: $n = 22$; *$p < .05$; **$p < .01$.

For the CCQ, a significant time-response item interaction was evident only for Item 1. The magnitude of the effect was again, small, with 13% of the variation accounted for by the effect based on the liberal measure, and 3% of the variation accounted for by the effect based on the conservative measure. Refer to Table 18 for the results.

For the BCQ, significant time-response item interactions were evident for Items 1 and 12. As with the previous analyses, the magnitude of the effect was small, with a maximum of 7% of the variation accounted for by the effect based on the liberal measure, and a maximum of 1% of the variation accounted for by the effect based on the conservative measure. Refer to Table 19 for the results.

Although significant differences were found using the ANOVA repeated-measures analysis, the measures of effect indicated that the interventions did not account for much of the variation in the dependent measures (see Table 19). Thus, these sets of results indicate partial support for *H5*.

Table 18
Repeated Measures ANOVA of Pre- and Post-CCQ Scores

Source	df	F	η^2	ω^2
CCQ Scenario 1; 16 questions				
Time	1	10.93**	.33	.01
Response Items	15	4.42**	.17	.11
Time x Response Item	15	3.20**	.13	.03
CCQ Scenario 4; 7 questions				
Time	1	.06	.00	.00
Response Items	6	.62	.03	.01
Time x Response Item	6	.33	.02	.00
CCQ Scenario 5; 5 questions				
Time	1	.33	.02	.00
Response Items	4	3.76**	.15	.10
Time x Response Item	4	.59	.03	.00
CCQ Scenario 10; 10 questions				
Time	1	.44	.02	.00
Response Items	9	2.46*	.10	.07
Time x Response Item	9	.60	.03	.00

Note: CCQ = Company Commander Questionnaire; n = 23; *p < .05; **p < .01.

Table 19
Repeated Measures ANOVA of Pre- and Post-BCQ Scores

Source	df	F	η^2	ω^2
BCQ Scenario 1; 13 questions				
Time	1	2.10	.07	.00
Response Items	12	3.30**	.11	.09
Time x Response Item	12	1.97*	.07	.01
BCQ Scenario 3; 10 questions				
Time	1	2.21	.08	.00
Response Items	9	3.10**	.09	.07
Time x Response Item	9	1.61	.05	.01
BCQ Scenario 12; 12 questions				
Time	1	.81	.03	.00
Response Items	11	4.21**	.12	.10
Time x Response Item	11	2.25*	.07	.01
BCQ Scenario 13; 10 questions				
Time	1	1.25	.04	.00
Response Items	9	5.07**	.15	.13
Time x Response Item	9	1.18	.04	.00

Note: BCQ = Battalion Commander Questionnaire; n = 33; *p < .05; **p < .01.

<u>Discussion</u>

The results of the intervention to improve officer tacit-knowledge scores were mixed. The Lieutenants seemed to fare worse on the post-measures as indicated by the results on PLQ Items 3 and 15. Repeated-measures ANOVA confirmed that PLQ Item 3 scores changed significantly. On the whole, it seems that Captains may have benefited the most from the intervention; however, that result is largely attributed to CCQ Item 1 as indicated by the pre- and post-correlation means and the repeated-measures ANOVA results. On the whole, the Majors and Lieutenant Colonels seem to have been unaffected by the intervention, as indicated by the mean pre- and post-correlation scores. BCQ Item 13 showed improvement but BCQ Item 12 showed deterioration. Repeated-measures ANOVA indicated that officers' scores changed significantly on Item 12 only. Furthermore, as indicated by the results on Table 15, out of 78 officers, only 12 showed improvement in their scores, while 10 officers showed deterioration in their scores. The scores of 56 officers remained unaffected. Given the low effect sizes in all of the analyses, we can conclude that the modest intervention we attempted did not have the intended impact on knowledge acquisition, and that the tacit knowledge of officers appears to be resilient.

Assuming that our TKML instruments are reliable, the resilience of tacit-knowledge in the short term should be reflected in the test-retest reliability of the tacit-knowledge scores. After removing the scores of two officers who exhibited a perfect reliability, and who presumably copied their pre-test responses, we correlated the pre- and post-test responses of each officer, and found a mean reliability score of .86 ($\underline{n}$ = 76). For each of the TKML versions the mean reliability scores were as follows: PLQ = .81 ($\underline{n}$ = 22), CCQ = .83 ($\underline{n}$ = 23), and BCQ = .90 ($\underline{n}$ = 31). Interestingly, the BCQ exhibited the highest reliability, and the PLQ the lowest reliability. These results may be attributed to group differences rather than to the reliability of the instruments per se. The officers who completed the BCQ were the most experienced officers (Majors & Lieutenant Colonels), while Lieutenants, who are the least experienced, completed the PLQ. Theoretically, those individuals that are most experienced would have the most reliable scores, because it would be more difficult to affect their tacit knowledge as compared to less-experienced individuals. Our previous analyses regarding the pre- and post-test scores appear to support this proposition.

As a further test of the reliability of the TKML instrument, we correlated each officer's pre-test score with his/her reliability score (i.e., the reliability score in this case is the correlation between pre- and post-test responses). We theorized that individuals with a high reliability score would have a higher tacit-knowledge score. We found a significant correlation between reliability and tacit-knowledge scores across all officers, $\underline{r}(76)$, = .35, $\underline{p}$ < .01. As indicated in the literature, individuals that are knowledgeable in a certain domain will perform more reliably and accurately than individuals who are less knowledgeable (Ericsson & Lehmann, 1996; Gentner, 1988; Johnson, 1988; VanLehn, 1996).

The fact that tacit-knowledge scores remained largely unaffected following a short intervention, demonstrates the importance of experience in tacit-knowledge

acquisition, and the resilience of tacit knowledge in individuals. In other words, it is difficult to change the tacit knowledge that individuals have acquired over a period of years by using a simple intervention technique centered on discussions of TKML scenarios. Although we believe that individuals can acquire tacit knowledge vicariously, this acquisition process takes time to unfold, and may be experience based. Individuals may have to observe how others use tacit knowledge in situ, before they adopt that tacit knowledge. In other words, individuals may have to see the cause and effect links represented by that tacit knowledge for themselves before they update their schemata and causal theories of the particular practical phenomenon. The adage "seeing is believing" may thus hold true for the vicarious acquisition of tacit knowledge.

We could also attribute the resilience of the officers' tacit-knowledge scores to three other factors. First, the discussions that occurred in the group sessions were focused on experiences that officers had. Whatever reflections the officers made as a result of listening to the discussions were beyond our control. Thus, whatever reflections occurred were unguided, which left the effect to chance. Also, the discussions themselves differed across groups as a function of the experiences of the officers that constituted the groups. Another complicating factor was that at most sites, one or two officers tended to dominate the discussion, which may have prevented others, who had something useful to add to the discussion, from speaking. Second, civilians led the group discussions. It is possible that the prompts that were made, and how those civilians interpreted the expert profile and shared this information with the officers, were incorrect. Furthermore, assuming that the civilians gave the officers the correct prompts, it is also possible that the officers did not utilize the recommendations of the civilians because they did not believe that civilians were capable of giving military officers good advice on leadership. Third, as regards the Lieutenants, it appears that they tended to do worse on the post-measures, although on the whole this difference was not significant. An examination of the items indicated that on two of the measures, Lieutenants performed significantly worse after the intervention. We assume that this result may have occurred because the Lieutenants were the most inexperienced officers of the group. Perhaps what limited experience the Lieutenants had, and the way in this inexperience was shared with others had deleterious effects on the Lieutenants' scores.

Given the exploratory nature of this intervention, it would be inappropriate to draw any definitive conclusions based on theses data. However, it appears that tacit-knowledge acquisition cannot be facilitated vicariously through a cursory intervention. Rather, to be able to affect tacit-knowledge, it may be necessary to have officers examine the metacognitive problem-solving process that underlies their knowledge acquisition. As noted in the literature, cognitive processes can be changed if individuals can monitor the processes associate with their knowledge acquisition. Because our case-study instruments are based on a theoretical model that addresses metacognitive functioning, using these instruments in an in-depth intervention should prove to be potentially valuable in the future.

GENERAL DISCUSSION

Summary of Results

Based on the results and the discussion, the following tentative conclusions can be drawn:

1. As military rank increases, differences relating to tacit-knowledge scores and officer experiences are more prominent.

2. Higher ranking officers have the most tacit-knowledge at all levels of the TKML.

3. Experience appears to be more related between adjacent levels than between nonadjacent levels of command.

4. More experienced officers can be distinguished from less experienced officers based on their metacognitive skills.

5. Compared to less experienced officers, more experienced officers are more aware of the metacognitive processes affecting their decision making.

6. More experienced officers have more tacit knowledge, and can more readily articulate this knowledge than less experienced officers.

7. Tacit-knowledge scores remain resilient after a facilitated group discussion.

Implications

In this section, we suggest the implications of these results, and make recommendations regarding theory, practice, and future research. Our theorizing is based on the assumption that practical intelligence can be viewed as a form of expertise that develops over time, and that differences between more experienced and less experienced individuals are evident if we can measure the processes associated with the development of expertise.

The results of this report provide tentative support for our framework of practical intelligence and tacit-knowledge acquisition, which attempts to model the cognitive processes that underlie intelligent behavior, how these processes function, and how they are interrelated. Our model serves to predict what should occur assuming that these processes have been correctly mapped, and can serve as a useful guide for future research. As our results and those of Hedlund et al. (1998) indicate, our construct of tacit knowledge can be reliably measured, and it can distinguish more experienced—as measured by military rank—from less experienced individuals. More experienced individuals have been shown to possess more tacit knowledge than less experienced individuals, and as reported by Hedlund et al., this possession of tacit knowledge is associated with leadership effectiveness. Our results also tentatively confirm that not only do more experienced individuals differ from less experienced individuals in possession of tacit knowledge, but that differences are also evident in the processes underlying tacit-knowledge acquisition. Membership in a particular rank thus served as a reliable predictor of the capabilities of officers, and the group differences that were evident in tacit knowledge and metacognitive-skills tests could be attributed to rank membership. The pattern of results indicated that our predictions were generally confirmed, suggesting

that there is some measure of validity to our theoretical framework. Nunnally and Bernstein (1994) mentioned that an important element underlying the validity of a theory is that its measures must "behave" as we expect them to "behave." Our results appear to tentatively support the notion that our measures "behaved as expected."

These results may have important implications for practice. First, our measures may have potential to select individuals for positions that require domain-specific knowledge, and the ability to adapt to, and learn from novel situations. Our extended scenarios may be more relevant than our current TKML scenarios for this purpose; however, this proposition requires empirical testing to determine the predictive validity of the PS1 and CS1 measures. Next, our extended scenario measures could be useful for developmental purposes, which is the focus of another ARI-sponsored contract that we are currently undertaking. The implications for developing and accelerating tacit-knowledge acquisition are far-reaching. By understanding how tacit knowledge is acquired and used, we can begin to design systems to reduce the cycle time of experiential learning, improve the decision-making process of individuals, and consequently improve the effectiveness and efficiency of organizations. We have made some inroads to understanding the processes of tacit-knowledge acquisition, and look with optimism to how an understanding of these processes can lead to the development of tacit knowledge.

Our results also have implications for future research. It appears that the TKML instrument measures what it was designed to measure, and that it should be retained for future use. Because the intensive case studies appear to be promising as assessment tools, it is important that their criterion validity be examined. Research efforts should also focus on designing more of these types of measures. Although these measures are difficult to code, advances in technology can allow for computerized coding—a major goal that we are currently exploring with Knowledge Analysis Technologies under another ARI-sponsored contract. As indicated by Landauer and Dumais (1997), and Landauer, Foltz, and Laham (1998), a machine-learning technology called Latent Semantic Analysis can be used to understand the semantic structure of text. As regards the facilitation of the acquisition of tacit knowledge, we now have an idea of what social scientists should consider when conducting such interventions. We will also take these results into consideration in designing our interventions on tacit-knowledge acquisition. We also anticipate that with further refinement and development of our measures, we will be able to test our theoretical framework using powerful confirmatory techniques, for example, structural-equation modeling. In this way, we will be able to determine if the structural framework and measurement model of our theory is supported by our data.

Limitations

Our tests—as with all quantitative paper-and-pencil tests—are limited in capturing context and actual behaviors. Although this concern has been somewhat addressed by the extended scenarios, they in turn have not been subject to tests of construct validation (i.e., predictive, discriminant, and incremental validity). Next, it appears the inclusion of Majors in tests at the battalion level was problematic, and that the BCQ may not be the appropriate tool to test the tacit knowledge of Majors, because

Majors do not command battalions. In the future, new tests should be constructed to test the domain-level knowledge of Majors, which in theory, is different to that of Lieutenant Colonels.

Our ANOVA repeated-measures analyses that tested for a tacit-knowledge acquisition effect were also limited. Recall that the officers rated the response options to certain scenarios. Some of the options were "good," while others were "bad." Thus the means of the options, based on the 1-9 rating scale that we used, differed. To ensure that the officer scores were scaled in the same manner for the analyses, each officer's score on the options was subtracted from the mean of the experts to create a difference score. According to Bereiter (1963), and Cronbach and Furby (1970), differences scores may suffer from unreliability.

The limitations of the results of intervention are also relevant for our contract with Knowledge Analysis Technologies, where the efficacy of a computer-mediated environment for vicarious learning is being tested. Although our results may have been explained by the reasons portrayed in the discussion section, a major limitation was that the group discussions were held under identified conditions. As indicated by Sosik (1997, 1998) and Sosik, Kahai, and Avolio (1999), computer-mediated group discussions are typically more successful when conducted in anonymous, as opposed to identified conditions. Furthermore, in computer-mediated groups, it becomes more difficult for one or two individuals to dominate the discussion. Because all individuals participate anonymously in those groups, it is feasible that they are more likely to contribute to discussions, and also to be more honest in their responses. Thus, we can anticipate that if a potential "identified-condition effect" exists, this will not affect the goals of Leadership Knowledge Forum, because leaders interact anonymously on this forum.

A limitation regarding the test-retest reliability scores that we reported for the TKML instrument may be that the officers remembered their pre-test responses, which may have inflated the reliability scores. Although this is a possibility, we believe that this effect was minimal, because of the large amount of response options that officers had to rate. For example, Lieutenants rated 40 responses on the PLQ, Captains rated 38 responses on the CCQ, and Majors/Lieutenant Colonels rated 45 responses on the BCQ. Because the response scale was from 1 to 9 and the relevance of the response options differed, it is highly unlikely that the officers could have potentially remembered between 342 (38*9) and 405 (45*9) response possibilities. Also, their memory would have been confounded by the time lapse and the discussion that was held. Therefore, we believe that the high test-retest reliability score must have been a function of the officers' tacit knowledge and the accuracy of our instruments in capturing that tacit knowledge.

Limitations are also evident in our extended-scenario tests. First, our extended scenario measures gauge potential but not actual problem-solving strategies. It is possible that responses may not accurately reflect officers' successful application of their practical intelligence and tacit knowledge in the field. For example, officers with a set of responses that closely match the expert profile may not make real-life decisions that reflect this ostensive tacit knowledge. Conversely, officers whose responses do not match those of

the experts may actually demonstrate effective problem-solving strategies in the field, and make good decisions based on previous experiences despite their lack of articulate answers to our inquiries. In order to address this question, subjective (e.g., peer and superior ratings) and objective (e.g., officer evaluation reports) behavioral measures should be used to establish the criterion validity of our measures.

Another limitation of the case study results was our definition of "expert." In order to evaluate tacit knowledge on the extended scenario, we defined a profile of expert responses based on a sample of what we considered to be experienced officers. We assumed that more experienced officers would have more expert responses on such a tacit knowledge inventory—the results of the TKML measure confirm this assumption, as do the results of the PS1 scenario. However, because the scenario used in this study concerned the actions of an officer at the level of Lieutenant, it is possible that high-level officers who have not been at the level of Lieutenant for several years may not be the most "expert" in resolving such a scenario. In order to address this possible confound, future studies should include other scenarios that are not confined to the platoon level (e.g. our CS1 scenario). Furthermore, the use of Majors in the expert profile may have been problematic, as indicated by the TKML tests, where Majors did not perform as well as Lieutenant Colonels for the reasons we cited previously. However, because Majors have served as Lieutenants and Captains, we believe that their inclusion in the expert profile did not substantially affect the results. Finally, in coding expert responses and scoring officer questionnaires, we also made a certain number of assumptions in classifying responses. In order to create an expert profile, slightly different responses— which we believe could be grouped in a common category—were included together. We used this expert schema to code the responses of the other officers. To the extent that we may have overlooked important distinctions between similar responses—one that may have reflected more insight than another—scores of certain individuals may have been distorted.

Conclusion

The purpose of this report was to present an integrated understanding of the nature and acquisition of tacit knowledge. Our intention was to examine the relation of tacit-knowledge to military rank and experience, how individuals acquire tacit knowledge, and the cognitive processes associated with practical problem solving. We demonstrated how tacit knowledge fits into a broader framework of practical intelligence, and how intelligent behavior can be explained by Sternberg's (1985, 1988, 1997) triarchic theory. Our theoretical propositions were based on established literature and the results confirmed most of our propositions. Our theoretical reasoning hinged on our model of practical intelligence and tacit-knowledge acquisition, and the notion that intelligence is a form of developing expertise. To the extent that our instruments accurately capture tacit knowledge and metacognitive problem-solving ability, our practical intelligence and tacit-knowledge acquisition framework appears to have received tentative support.

Tacit knowledge permeates much of our automatic cognitive functioning. Touch-typing this report is an example, as is reading this report. Our skills associated with

typing and reading are a function of experience, and our ability to learn from this experience. Once we have mastered a certain domain of knowledge, our performance in that domain appears to be effortless, efficient, and accurate. As we have demonstrated in this report, tacit knowledge is applicable to such complex interactive tasks as leadership, which is based more on implicit than rational-methodical processes. Tapping into this knowledge base, and understanding how it functions, is a strategic imperative for all organizations. We believe that we have a good understanding of the processes associated with tacit-knowledge acquisition; now the task for future research remains to uncover ways in which it can be facilitated and accelerated. Reimer (1999), former U.S. Army Chief of Staff, argued that leadership and accurate decision-making must infuse all levels of the Army so that it can function as a learning organization, and continually increase its capacity to react rapidly to changing external conditions. Indeed, Reimer noted,

> A learning organization is one that discovers how to tap its soldiers' commitment and capacity to learn. . . . Learning organizations underwrite prudent risks and honest errors. Human beings in a complex organization doing difficult jobs, often under pressure, will make mistakes. Good leaders use those mistakes to figure out how to do things better the next time, and they share what they have learned with other members of the organization. (p. 294)

The capacity of individuals to learn is of critical importance to organizational success. What knowledge individuals have today has an expiry date. Also, what knowledge individuals acquire in formal settings may not be relevant or applicable to practice. Individuals must therefore be able to regulate their own learning, and be able to acquire the necessary skill and knowledge to adapt to their environment today, and in the future.

In conclusion, Taylor and Rosenbach (1984) noted, "Providing a stable succession of capable leaders has always been a central concern for military planners" (p. 1). We hope that this report partly addresses this concern, and that our model of practical intelligence and tacit knowledge acquisition serves as a useful guide for future research and training endeavors.

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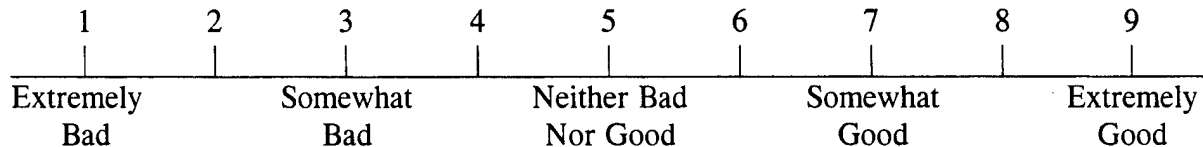Zaccaro, S. J., & Klimoski, R. J. (2001). The nature of organizational leadership. In S. J. Zaccaro, & R. J. Klimoski (Eds.), The nature of organizational leadership (pp. 3-41). San Francisco: Jossey-Bass Publishers.

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APPENDIXES

Appendix A: Sample Tacit-Knowledge Item

```
    1       2       3       4       5       6       7       8       9
    |       |       |       |       |       |       |       |       |
____|_____|_____|_____|_____|_____|_____|_____|_____|_____
Extremely        Somewhat        Neither Bad       Somewhat        Extremely
   Bad              Bad            Nor Good           Good             Good
```

P3. You have spent two months working with your new battery commander. In his last position as the Fire Support Officer for an infantry battalion he supervised a shorthanded team. Consequently, he was required to perform many duties himself. Your commander still tries to stay involved in all of the day-to-day details of running the unit, and he generally delegates tasks less often than you would like. You believe that your commander is overburdened, and you are worried about the consequences of his time-management techniques. What should you do?

1. Has any situation like this happened to you or someone you know?
Please circle <u>Yes</u> or <u>No</u> If so, please explain.

_____ If you know that the battery commander intends to give someone a task, speak to that person before the battery commander does, so that he or she has already started the task before the battery commander meets with him or her.

_____ Wait to take action on specific things until <u>after</u> he mentions them to you.

_____ Help your battery commander to better manage his time in any way you can.

_____ Don't wait to be told what to do--anticipate what needs to be done, and if you are capable, do it.

_____ If something needs to be done but you can't do it, find someone else who can and get him/her involved--without being asked by the battery commander.

_____ Offer to take care of specific tasks <u>before</u> he mentions them to you.

_____ When he returns from command and staff meetings, meet with him right away by yourself and write down everything that has to be done.

_____ Rely on the NCO chain of command; deal with the appropriate NCO and get NCO support.

_____ Go to the first sergeant and/or executive officer and ask for suggestions about what to do about the commander's management style.

_____ Ask the battery commander often what you can do to help and to relieve his task burden.

_____ Assume this is just the way he is and do your best to get along.

Appendix B: Platoon Scenario 1 (PS1)

The Insubordinate Soldier

OVERVIEW
Researchers at Yale University and the U.S. Army Research Institute have been exploring ways to identify and develop effective Army leaders. The focus of this work has been to understand the role of tacit knowledge (e.g., unspoken, practical knowledge) in facilitating successful military leadership. Tacit knowledge is knowledge that leaders acquire primarily through their everyday experiences and that allows them to deal more effectively with the many challenging situations they face as leaders. Our current objective is to understand how leaders acquire such knowledge in the process of solving complex problems so that tools and techniques can be generated to enhance leadership development.

SCENARIO INSTRUCTIONS
The following presents a leadership case scenario. The scenario describes a problem similar to an actual problem encountered by a military leader. You are asked to take the role of the leader described. You are provided with some background information about the problem and various accompanying materials (e.g., memos, policy documents) that might be useful in understanding the problem. You are asked to read through the scenario and determine the nature of the problem, what information is useful for understanding the problem and develop a solution. There are a series of questions at the end of the scenario to help you formulate a response. There are no right or wrong answers to these questions. We are interested in your assessment of the situation and the response you develop to it. The scenario should take 20-30 minutes to complete.

SCENARIO OVERVIEW

You are 1LT Sam Martin, platoon leader. You recently took command of a sensitive technical unit. You are busy preparing for an important training exercise tomorrow. This unit was recognized for outstanding performance in its previous exercise and you are hoping for a great show tomorrow, especially since it is your first major event as the new platoon leader. One of your soldiers, SPC Steven M. Jones, is critical to the unit's success because he has a specialized skill your unit needs. However, he seems to have a problem with taking orders from you. Now, on the eve of the exercise, he has refused to obey an order from your superior and you must decide how to deal with the situation.

TIMELINE OF EVENTS

At 1800 hours, Captain Dennis Murphy issues a directive that all soldiers in the company should be in their rooms with lights out by 2000 hours. You informed your PSG about the order. He expressed concern that the soldiers will likely not be ready to go to sleep given their anxiety about tomorrow. You acknowledge that the time is early but reinforce that an order is an order.

At 2000 hours, PSG Sears came to inform you that a group of soldiers was playing cards and that he told them to finish the game and to turn the lights out. You promptly went to talk to the group and found that SPC Jones was involved. When you told SPC Jones to turn the lights out, he indicated that the 2000-hour order was ridiculous and remarked that there was no harm if they stayed up a little later. You again stated the seriousness of the order and the potential repercussions if CPT Murphy discovers that they have not obeyed. You told SPC Jones that you would return in 20 minutes to check on them and warned that if the lights were not out at that point, Jones would be removed from the next day's activities.

Outside the barracks, you discussed the situation with PSG Sears. You mentioned that the last time SPC Jones made an outburst, you thought it was due to problems he was having at home. He seemed to respond to counseling after that incident. PSG Sears raised the point that the unit would suffer if Jones was not well rested or unable to attend. Plus, CPT Murphy would have to be informed as to why Jones was kept out of the exercise. You commented on the fact that it could be worse, remembering how LT Johnson had to deal with soldiers drinking the night before his exercise.

At 2030 hours, you return to find Jones and 3 other soldiers still awake. They seem far from concerned by your presence.

IN-BASKET

The following materials were in your in-basket today:

1. Article Regarding Soldier Retention
2. Memo Regarding Drinking Policy
3. Memo Regarding Maj. General's Visit
4. Jones' Reenlistment Forms

These items are attached for your review.

RETENTION RATES ON RISE

by Brooke Ruivivar

WASHINGTON (Army News Service, March 16, 2000) - Army retention rates are healthy, Lt. Gen. David Ohle, deputy chief of staff for personnel, told the House Armed Services Committee March 8.

"Through the first quarter of fiscal year 2000, we have re-enlisted 102.9 percent of our first quarter mission and are on track to make the 68,000 re-enlistment mission that is required to sustain our 480,000 soldier Army," Ohle said.

Ohle appeared before the Subcommittee on Military Personnel, explaining the retention and recruiting challenges the Army faces. Although the Army's re-enlistment program is currently doing well, he said re-enlistment factors and programs need to be closely monitored so they continue to succeed. He said the Army needed to offer stronger incentive packages to encourage soldiers to re-enlist.

"Civilian employers are actively recruiting service members," Ohle said. "They are offering bonuses and benefit packages that we simply cannot expect to match under current bonus allocation rules and constrained budgets."

Ohle also touched on the recent recruiting problems the Army has faced. He cited "the combined effects of the strongest economy in 40 years, the lowest unemployment rate since the all-volunteer force began and a low propensity to serve" as the Army's biggest recruiting obstacles.

So far this year, the Army has exceeded its active Army accession requirements, Ohle said. The Army National Guard is meeting its requirements, but the Army Reserve is about 3,000 below its goal.

Last year a recruiting shortfall was predicted, and more effort was put into retention to make up the deficit, Ohle said. The Army retained 109.5 percent of its re-enlistment goal: 6,147 soldiers above its 65,000 re-enlistment mission in fiscal year 1999.

This year, the Army's retention mission is 68,000. To meet that, Ohle said, the Army is offering more incentive packages to re-enlisting soldiers.

"The Selective Re-enlistment Bonus, or SRB, offers monetary incentives to eligible soldiers, primarily in the grades of specialist and sergeant, to re-enlist in skills that are critically short or that require exceptional management," Ohle said.

The SRB program received a $44 million dollar increase in the FY00 Congressional Markup, which brought its budget to $107 million. The SRB program is designed to increase re-enlistments in infantry, armor, special forces, intelligence, communications, maintenance and foreign languages.

The Targeted Selective Reenlistment Bonus program, which began as a test program at three installations last year, has been expanded to 11 more installations.

"The TSRB pays a re-enlisting soldier a higher amount of money to stay on a station at a location in the program or to accept an option to move," Ohle said.

He said the officer retention rates are slightly below the fiscal year 2000 mission. Officer retention rates for captains, in particular, are falling. Ohle said the effect of the captain shortage is counterbalanced by an overage of lieutenants.

Memorandum

To: Platoon leaders

From: CPT Murphy

Date: 10/4

Re: Army Substance Abuse Policy

In light of recent events, I am asking all of you to review Chapter 1, Section IV of AR600-85 <u>Army Substance Abuse Program (ASAP).</u> Please ensure that you and your soldiers are familiar with and understand the policy and its contents.

Sincerely,

CPT Murphy

Memorandum

To: Platoon leaders

From: CPT Murphy

Date: 10/4

Re: Maj. Gen. Doug McKinney

During our training exercise, we will be honored by a visit by our Division Commander, Maj. Gen Doug McKinney. Maj. Gen. McKinney is touring all of the companies and their respective units to observe first hand the division's operational readiness. It is very important that we be at our absolute best so as to uphold the reputation this entire company has worked so hard to earn.

Sincerely,

CPT Murphy

REQUEST FOR REENLISTMENT OR EXTENSION IN THE REGULAR ARMY

For use of this form, see AR 601-280; the proponent agency is ODCSPER

SECTION I - SOLDIER'S REQUEST

1. TO	2. FROM
CPT Dennis Murphy CO C, 1ST BN, 92ND SIGNAL APO AE 998574	SPC Steven M. Jones 049-78-6754 CO C, 1ST BN, 92ND SIGNAL APO AE 998574

3. REQUEST I BE AUTHORIZED TO *(Select one)*

☒ a. REENLIST IN THE ACTIVE COMPONENT.

☐ b. EXTEND MY ENLISTMENT FOR THE FOLLOWING REASON: _____

4. ACCRUED LEAVE OPTIONS *(Select one)*

☐ a. I DESIRE TO CASH IN _____ DAYS OF ACCRUED LEAVE.

☒ b. I DO NOT DESIRE TO CASH IN ACCRUED LEAVE.

☐ c. I AM EXTENDING MY PRESENT ENLISTMENT AND HAVE BEEN COUNSELED ON CASHING IN ACCRUED LEAVE.

5. DATE	6. SIGNATURE
17/10/00	Steven M. Jones

SECTION II - COMMANDER'S CERTIFICATION

7. COMMANDER'S DETERMINATION OF QUALIFICATION *(Select one)*

☐ a. SOLDIER IS FULLY QUALIFIED FOR REQUESTED ACTION.

☒ b. SOLDIER IS NOT FULLY QUALIFIED AND REQUIRES WAIVER. *(Select 8b or 8c(1) below)*.

☐ c. SOLDIER IS FULLY QUALIFIED, BUT IS NOT RECOMMENDED FOR FURTHER SERVICE. *(Select 8c(2) below)*

8. COMMANDER'S DETERMINATION/RECOMMENDATION FOR CONTINUED SERVICE WITHIN THE ARMY *(Select one)*

☐ a. APPROVED

☒ b. RECOMMEND APPROVAL. DA FORM 3072 IS ATTACHED.

☐ c. DISAPPROVED

    ☐ (1) I DISAPPROVE THE SOLDIER'S REQUEST FOR WAIVER OF DISQUALIFICATION.

    ☐ (2) I HAVE INITIATED A BAR TO REENLISTMENT UNDER THE PROVISIONS OF CHAPTER 8, AR 601-280.

9. TYPED NAME, RANK, AND BRANCH OF COMMANDER
Denis Murphy, CPT, AR

10. SIGNATURE	11. DATE
CPT Dennis Murphy	21/10/00

DA FORM 3340-R, DEC 94   EDITION OF MAY 88 IS OBSOLETE   USAPPC V1.00

WAIVER OF DISQUALIFICATION FOR REENLISTMENT/PROMOTION IN THE REGULAR ARMY	DATE 21/10/00

WAIVER OF DISQUALIFICATION FOR
REENLISTMENT/PROMOTION IN THE REGULAR ARMY
For use of this form see AR 601-280; the proponent agency is DCSPER

DATE 21/10/00

DISQUALIFICATION

TO: *(Include ZIP Code)*

MAJ RON JULIARD
1ST BN, 92ND SIGNAL
APO AE 998574

FROM: *(Include ZIP Code)*

CPT DENNIS MURPHY
CO C, 1ST BN, 92ND SIGNAL
APO AE 998574

PARAGRAPH 3-9a   **AR 601-280**

TYPE INSUBORDINATION

1. RANK/NAME *(Last, First, Middle)*	2. SSN
SPC JONES, STEVEN M.	049-78-6754

3. PHYSICAL STATUS	P	U	L	H	E	S	CODE	DATE OF PHYSICAL	DATE OF PROFILE	4. HT.	5. WT.
	1	1	1	1	1	1	A	2000 Jun. 12	NONE	70	165

BRIEF SUMMARY OF ASSIGNMENT LIMITATIONS

NONE

6. SQT DATA

PMOS

SCORE

DATE

7. TIME LOST DURING CURRENT SERVICE

DATES *(From/To)*	NO. OF DAYS	REASON
NONE		

8. COURTS-MARTIAL DURING CURRENT TERM OF SERVICE

TYPE	OFFENSE	DATE OF CONVICTION	SENTENCE
NONE			

9. ARTICLE 15 DURING CURRENT TERM OF SERVICE

ARTICLE/TYPE	OFFENSE	DATE OF CONVICTION	SENTENCE
86/CO	INSUBORDINATION	1999 NOV 14	1 WEEK SUSPENSION W/O PAY

10. LETTER(S) OF INDEBTEDNESS

CREDITOR	AMOUNT	DATE OF LETTER	DISPOSITION
NONE			

11. RECOMMENDATION OF COMMANDING OFFICER WITH REASONS AND JUSTIFICATIONS *(USE CONTINUATION SHEET PER AR 340-15, IF REQUIRED)*

SPC STEVEN M. JONES HAS DEMONSTRATED THAT HE IS FIT FOR CONTINUING SERVICE DESPITE HIS PAST ATTITUDE AND INSUBORDINATION. HE HAS SINCE DISPLAYED OUTSTANDING APTITUDE IN HIS POSITION AND HAS BEEN A VALUABLE MEMBER OF HIS UNIT.

12. LIST OF ENCLOSURES *(Double column, if necessary)*

I ENCL

1. DA FORM 3340-R

13. TYPED NAME, RANK AND BRANCH OF COMMANDER	SIGNATURE
DENNIS MURPHY, CPT, AR	CPT Dennis Murphy

DA FORM 3072-R, MAY 88   PREVIOUS EDITION OF JAN 88 IS OBSOLETE.   USAPPC V1.00

<u>QUESTIONS</u>

Based on the information you have read about the situation and your experience as a commander, please answer the following questions:

1. What do you consider to be the main problem to be addressed in this scenario? Why do you consider it to be the main problem?

2. What course of action would you take to address this problem? Why do you consider this course of action to be the most appropriate?

3. What information did you feel was most relevant to understanding the problem? What assumptions did you make about the problem? What additional information/resources would you seek to help define and/or solve the problem?

4. What outcome do you hope will result from your course of action? What obstacle(s) do you foresee to achieving that outcome?

Meeting Training Needs

OVERVIEW

Researchers at Yale University and the U.S. Army Research Institute have been exploring ways to identify and develop effective Army leaders. The focus of this work has been to understand the role of tacit knowledge (e.g., unspoken, practical knowledge) in facilitating successful military leadership. Tacit knowledge is knowledge that leaders acquire primarily through their everyday experiences and that allows them to deal more effectively with the many challenging situations they face as leaders. Our current objective is to understand how leaders acquire such knowledge in the process of solving complex problems so that tools and techniques can be generated to enhance leadership development.

SCENARIO INSTRUCTIONS

The following presents a leadership case scenario. The scenario describes a problem similar to an actual problem encountered by a military leader. You are asked to take the role of the leader described. You are provided with some background information about the problem and various accompanying materials (e.g., memos, policy documents) that might be useful in understanding the problem. You are asked to read through the scenario and determine the nature of the problem, what information is useful for understanding the problem and develop a solution. There are a series of questions at the end of the scenario to help you formulate a response. There are no right or wrong answers to these questions. We are interested in your assessment of the situation and the response you develop to it. The scenario should take 20-30 minutes to complete.

SCENARIO OVERVIEW

You are CPT Dan Smith, commander of an armor company. You have been commander for 17 months and are up for reassignment soon. You just began what you hope is your final NTC rotation as company commander. Upon arrival at NTC, you were given a new platoon and have concerns that the platoon leader is weak tactically. The battalion CO assigned him to your company in order to "make or break" him. You also receive notice upon arrival that your company has been cross-attached to a mechanized infantry battalion to form a task force. You have five platoons and you need to decide which platoon to send over to the infantry battalion.

TIMELINE OF EVENTS

The day before your NTC rotation, you received a phone message from your commander, LTC Brison. He was calling to follow up on LT Marx, the new platoon leader placed under your command. He indicated that Marx was a good officer, but a bit weak in his tactical decision making skills. He thought you would be the best person to help him overcome these deficits before his next promotional review. He passed along Marx's most recent OER for your reference (A copy of the OER is attached).

At the end of Day 1 of NTC, your company did not perform as well as you had hoped. LT Marx's unit lost two tanks to enemy fire. LT Johnson' unit was ambushed by OPFOR and lost three tanks, but made two kills. LT Lawson's unit made three enemy kills: 1 tank and 2 Bradley fighting vehicles. LT Thurman's unit provided fire support for LT Lawson's unit, scoring 2 kills. LT Larami's unit made 2 kills and provided fire support for LT Marx's unit. (A summary of the units' strengths and weaknesses is attached.)

On Day 2 of NTC, you received a memo from the brigade commander, COL Taylor, requesting that you provide a tank platoon to support mechanized infantry company A on Day 4 of NTC. The mission was to be a direct fire attack on the OPFOR in the northwest quadrant

After receiving the request, you met with your 1SG to get his advice on which platoon to send. He reviewed the plan for the next few days. The company would be coordinating offensive operations against OPFOR and needed to make sure that the fire line was well-coordinated. He mentioned that these were activities the units were best prepared for and were expected to do well in. He was hesitant to send any units, but suggested Marx's unit because he was a bit wary of how they would perform during the rest of the training.

Later that day, PSG Hynes of LT Marx's unit came to speak with you. He indicated that one of his tank commanders recently returned from a gunnery drill and gained insight about some state-of-the-art training techniques. He indicated that not many people are aware of these techniques yet, which really could provide an advantage. His unit had already tested them and they seemed to work well. He felt that these techniques could really help his unit, especially since they've not done well in the past. He was concerned

that LT Marx was apprehensive about using them, but he thought that you might be more willing to give them a try.

OFFICER EVALUATION REPORT
For use of this form, see AR 623-105; the proponent agency is ODCSPER

PART I - ADMINISTRATIVE DATA

a. NAME (Last, First, Middle Initial)	b. SSN	c. RANK	d. DATE OF RANK			e. BRANCH	f. DESIGNATED / RANK (MO) APPLICATION
Marx, Devon C.	304-32-7846	2LT	Year	Month 11	Day 01		

g. UNIT, ORG., STATION, ZIP CODE OR APO, MAJOR COMMAND	h. REASON FOR SUBMISSION	
A Company, 23rd Infantry, 5th Armor Division	11	Annual

i. PERIOD COVERED						j. RATED MONTHS	k. NONRATED CODES	l. NO. OF ENCL	m. RATED OFFICER COPY (Check one and date)	n. PSB Date	n. PSB INITIAL	o. CMD CODE	p. PSB CODE
FROM			THRU						X 1. Given to Officer				
Year	Month	Day	Year	Month	Day					04 Nov.		E7	
11	02		11	03		12	Q		2. Forwarded to Officer				

PART II - AUTHENTICATION (Rated officer's signature verifies officer has seen completed OER Parts I-VII and the admin data is correct)

a. NAME OF RATER (Last, First, MI)	SSN	RANK	POSITION	SIGNATURE	DATE
Riggs, Charles C.	304-73-9438	CPT	CO Commander	*Murphy C. Riggs*	07 Nov.

b. NAME OF INTERMEDIATE RATER (Last, First, MI)	SSN	RANK	POSITION	SIGNATURE	DATE

c. NAME OF SENIOR RATER (Last, First, MI)	SSN	RANK	POSITION	SIGNATURE	DATE
Brison, John L.	049-78-4963	LTC	BN Commander	*John Brison*	09 Nov.

SENIOR RATER'S ORGANIZATION	BRANCH	SENIOR RATER TELEPHONE NUMBER	E-MAIL ADDRESS	
23rd BN, 23rd Infantry, 5th Armor Division				

d. This is a referred report, do you wish to make comments? ☐ Yes, comments are attached ☐ No	e. SIGNATURE OF RATED OFFICER *Devon Marx*	DATE 10 Nov.

PART III - DUTY DESCRIPTION

a. PRINCIPAL DUTY TITLE	b. POSITION AOC/BR

c. SIGNIFICANT DUTIES AND RESPONSIBILITIES. REFER TO PART IVe, DA FORM 67-9-1

Platoon Leader for an Abrams tank platoon consisting of four M1A1 Abrams tanks and their crews. Responsibilities include maintaining the discipline, standards and performance necessary for a combat ready unit. Subordinate development and maintenance of PT standards throughout the platoon are also key responsibilities.

PART IV - PERFORMANCE EVALUATION - PROFESSIONALISM (Rater)

CHARACTER Disposition of the leader: combination of values, attributes, and skills affecting leader actions

a. ARMY VALUES (Comments mandatory for all "NO" entries. Use PART Vb.)

	Yes	No		Yes	No
1. HONOR: Adherence to the Army's publicly declared code of values	X		5. RESPECT: Promotes dignity, consideration, fairness, & EO	X	
2. INTEGRITY: Possesses high personal moral standards; honest in word and deed	X		6. SELFLESS-SERVICE: Places Army priorities before self	X	
3. COURAGE: Manifests physical and moral bravery	X		7. DUTY: Fulfills professional, legal, and moral obligations	X	
4. LOYALTY: Bears true faith and allegiance to the U.S. Constitution, the Army, the unit, and the soldier	X				

b. LEADER ATTRIBUTES / SKILLS / ACTIONS: First, mark "YES" or "NO" for each block. Second, choose a total of six that best describe the rated officer. Select one from ATTRIBUTES, two from SKILLS (Competence), and three from ACTIONS (LEADERSHIP) Place an "X" in the appropriate numbered box with optional comments in PART Vb **Comments are mandatory in Part Vb for all "No" entries.**

b.1. ATTRIBUTES (Select 1) Fundamental qualities and characteristics	1. MENTAL [YES] NO Possesses desire, will, initiative, and discipline	X PHYSICAL [YES] NO Maintains appropriate level of physical fitness and military bearing	3. EMOTIONAL [YES] NO Displays self control; calm under pressure
b.2 SKILLS (Competence) (Select 2) Skill development is part of self development; prerequisite to action	1. CONCEPTUAL [YES] NO Demonstrates sound judgment, critical/creative thinking, moral reasoning	X INTERPERSONAL [YES] NO Shows skill with people: coaching, teaching, counseling, motivating and empowering	X TECHNICAL [YES] NO Possesses the necessary expertise to accomplish all tasks and functions
	4. TACTICAL Demonstrates proficiency in required professional knowledge, judgment, and warfighting		YES [NO] X

b.3. ACTIONS (LEADERSHIP) (Select 3) Major activities leaders perform: influencing, operating, and improving

INFLUENCING Method of reaching goals while operating / improving	X COMMUNICATING [YES] NO Displays good oral, written, and listening skills for individuals / groups	2. DECISION-MAKING [YES] NO Employs sound judgment, logical reasoning and uses resources wisely	X MOTIVATING [YES] NO Inspires, motivates, and guides others toward mission accomplishment
OPERATING Short term mission accomplishment	X PLANNING [YES] NO Develops detailed, executable plans that are feasible, acceptable, and suitable	5. EXECUTING [YES] NO X Shows tactical proficiency, meets mission standards, and takes care of people/resources	6. ASSESSING [YES] NO Uses after action and evaluation tools to facilitate consistent improvement
IMPROVING Long term improvement in the Army its people and organizations	7. DEVELOPING [YES] NO Invests adequate time and effort to develop individual subordinates as leaders	8. BUILDING [YES] NO Spends time and resources improving teams, groups and units; fosters ethical climate	9. LEARNING [YES] NO Seeks self improvement and organizational growth; envisioning, adapting and leading change

c. APFT: PASS	DATE: AUG 2000	HEIGHT: 73	WEIGHT: 184	YES

d. JUNIOR OFFICER DEVELOPMENT - MANDATORY YES OR NO ENTRY FOR RATERS OF LTs AND WO1s.
WERE DEVELOPMENTAL TASKS RECORDED ON DA FORM 67-9-1a AND QUARTERLY FOLLOW-UP COUNSELINGS CONDUCTED? [YES] X   [NO]   [NA]

DA FORM 67-9, OCT 97   REPLACES DA FORM 67 8, 1 SEP 79, WHICH IS OBSOLETE, 1 OCT 97   USAPA V2.01

NAME Marx, Devon C.	SSN 304-32-7846	PERIOD COVERED 11/02 - 11/03

PART V - PERFORMANCE AND POTENTIAL EVALUATION (Rater)

a. EVALUATE THE RATED OFFICER'S PERFORMANCE DURING THE RATING PERIOD AND HIS/HER POTENTIAL FOR PROMOTION

☐ OUTSTANDING PERFORMANCE, MUST PROMOTE	☒ SATISFACTORY PERFORMANCE, PROMOTE	☐ UNSATISFACTORY PERFORMANCE, DO NOT PROMOTE	☐ OTHER (Explain)

b. COMMENT ON SPECIFIC ASPECTS OF THE PERFORMANCE AND POTENTIAL FOR PROMOTION. REFER TO PART III, DA FORM 67-9 AND PART IVa, b, AND c DA FORM 67-9-1.

LT Marx has potential to be an effective leader. He is strong in his self discipline and physical training, and maintains a high standard of Army values. However, LT Marx has marginal tactical skills and often has difficulty assessing situations in terms of mission goals, which has led to problematic decision making. Because of this, his soldiers have performed poorly on some important tactical exercises, and two of his crews did not pass gunnery Table VIII at his last range. LT Marx is dedicated to the Army and with some work could become a successful officer.

c. IDENTIFY ANY UNIQUE PROFESSIONAL SKILLS OR AREAS OF EXPERTISE OF VALUE TO THE ARMY THAT THIS OFFICER POSSESSES FOR ARMY COMPETITIVE CATEGORY CPT THROUGH LTC, ALSO INDICATE A POTENTIAL CAREER FIELD FOR FUTURE SERVICE.

PART VI - INTERMEDIATE RATER

PART VII - SENIOR RATER

a. EVALUATE THE RATED OFFICER'S PROMOTION POTENTIAL TO THE NEXT HIGHER GRADE

☐ BEST QUALIFIED	☒ FULLY QUALIFIED	☐ DO NOT PROMOTE	☐ OTHER (Explain below)

I currently senior rate _____ officer(s) in this grade
A completed DA Form 67-9-1 was received with this report and considered in my evaluation and review   ☐ YES   ☐ NO (Explain in c)

b. POTENTIAL COMPARED WITH OFFICERS SENIOR RATED IN SAME GRADE (OVERPRINTED BY DA)

	c. COMMENT ON PERFORMANCE/POTENTIAL
☐ ABOVE CENTER OF MASS (Less than 50% in top box; Center of Mass if 50% or more in top box)	LT Marx has demonstrated a strong commitment to the Army. However, his weaknesses in tactical decision making are potentially detrimental to his units. His promotability depends on his ability to show improvement in this area.
☐ CENTER OF MASS	
☒ BELOW CENTER OF MASS RETAIN	
☐ BELOW CENTER OF MASS DO NOT RETAIN	d. LIST 3 FUTURE ASSIGNMENTS FOR WHICH THIS OFFICER IS BEST SUITED. FOR ARMY COMPETITIVE CATEGORY CPT THROUGH LTC, ALSO INDICATE A POTENTIAL CAREER FIELD FOR FUTURE SERVICE. Tank gunner, driver or loader. Tank commander.

DA FORM 67-9, OCT 97 (Reverse)   USAPA V2.01

C-5

Company B Unit Performance Chart.

Platoon	Platoon Leader	Platoon Sergeant	Strongest Skills	Most successful exercises	Areas needing improvement	Training recommendations
Platoon 1 Tank Platoon Red	2LT Michael Lawson	SFC Jim Jorgenson	-Maneuver coordination, planning, and execution -PT	-Formation maneuvering -Over-watch occupation	-Safety	Seminar and demonstration on equipment safety
Platoon 2 Scout Platoon White	2LT George Thurman	SFC Larry Rush	-Detection avoidance -Gunnery skills	-Indirect fire support	-PT -Morale	Focus on PT
Platoon 3 Tank Platoon Green	2LT Hariem Johnson	SFC James Caroway	-Gunnery skills -Combat readiness	-Direct fire attacks, - Tactical positioning	-PT	Focus on PT
Platoon 4 Scout Platoon Blue	2LT Doug Larami	SFC Tim Lanahan	-Maneuver coordination -Troop morale	-Coordinating attacks -Indirect fire support	-Mobile target acquisition	Drill simulations

QUESTIONS

Based on the information you have read about the situation and your experience as a commander, please answer the following questions:

1. What do you consider to be the main problem to be addressed in this scenario? Why do you consider it to be the main problem?

2. What course of action would you take to address this problem? Why do you consider this course of action to be the most appropriate?

3. What information did you feel was most relevant to understanding the problem? What assumptions did you make about the problem? What additional information/resources would you seek to help define and/or solve the problem?

4. What outcome do you hope will result from your course of action? What obstacle(s) do you foresee to achieving that outcome?

Appendix D: Platoon Commander Stories

Story 1: You are a leader of an infantry platoon. When you first took over the platoon, a strong platoon sergeant had just left and been replaced by a squad leader. The platoon sergeant (PSG) had been promoted from among his peers without a change in rank. He failed to follow up on tasks he assigned to his soldiers and the platoon was not meeting standards in the field. During a NTC rotation, the soldiers piled out of vehicles and lit cigarettes rather than setting up a secure perimeter as their battle drill dictated. Squad leaders were not keeping leader books up to date and often could not account for the whereabouts of the men in their squads. You counseled the PSG about his failure to establish discipline in the platoon. You met with the squad leaders and explained to them that they must obey the PSG as they would obey you. The squad leaders responded by complaining about the PSG.

Story 2: You are a platoon leader. On the night before deploying back from a field exercise, the commander issued a directive that all soldiers would be in bed by 2000 hours. Your FIST team was in one tent playing cards. At 2000 hours you told your FIST team to go to bed. One NCO protested and asked you if they could finish playing a game of cards. You told them it would be okay to finish the game and then turn lights out. Some time later, you heard the FIST team still playing cards. You told them a second time to turn the lights out and go to bed. The same NCO that protested before told you that they did not want to go to bed. He told you that they were grown men and should not have to be put to bed at 2000 hours. Your team continued to talk. You again told them to go to bed. The NCO said no. You told the NCO that if he did not stop talking, you would take him for a run at 0500 hours. The team continued to talk. You returned to Garrison at 0300 hours and got a little sleep. At 0500 you went to the NCO's room to take him on a run, but he refused.

Story 3: While the platoon leader is responsible for everything in the platoon, some things are better handled by the NCOs. Once my driver had an attitude problem in the field. He was mouthing off to me on top of the turret in front of the rest of the platoon. I let myself get into a pissing contest with him. This was a big mistake on my part that had some long-term effects. Morale in the platoon went down for awhile. I had lost some of the respect from my soldiers and it took me about three weeks to build it back. I should have gone to the PSG and told him to take care of this problem. I did this the next day. The PSG went to the gunner on my tank, who happens to be the driver's rater, and the gunner talked to the guy and squared him away. (Corresponds to P5 of the TKML.)

Story 4: I learned about what happens to soldiers when they have reached their limit at Victory Focus. One squad was given the mission to put in a minefield for the Infantry battalion. I picked the 2nd Squad because they had better equipment and they

were better trained to do the job. But the squad really complained. This happened toward the end of the exercise and they were real tired. So I told them what I wanted done and made the standards clear. When I returned to check, the minefield was not up to standards and the squad was sitting on top of the track eating MREs. I talked to the squad leader, pointing out that the minefield was not up to standard. He told me the squad wasn't interested in my standards and that what they did was the best I was going to get. I tried to convince him that I wouldn't give them another mission until they had a chance to rest. I just needed them to do just one more mission As it turned out, they did re-do the minefield to standard and I gave them some time off to rest. (Corresponds to P9 of the TKML.)

Appendix E: Company Commander Stories

Story 1: You are a company commander of an Engineering Battalion. Your soldiers have not fired their weapons in the last 13 months. Every time you had a weapons qualification range schedule, the battalion S3 either failed to submit the ammunition request in a timely manner or made a mistake in forecasting the battalion's ammunition consumption. When the battalion runs short on ammunition for qualification, the battalion S3 has given priority to the three line companies because they are real combat units. This rationale for allocating ammunition and the incompetence of the battalion S3 section upsets you. You feel that the soldiers in your company are just as much combat soldiers as the soldiers in the line units and that the incompetence of the battalion staff is preventing them from being properly trained. You also are frustrated because the battalion commander will not take action to make the S3 accountable for responsibilities or take action to fix the problem in the future. Also, the battalion commander accepts the S3's fix of always rescheduling the range at a later day, in order to give the brigade commander the perception that the problem is being fixed. At the last brigade training brief, you briefed that only 33% of your soldiers were qualified on their weapons and that none of your crew-served weapon teams were qualified. From your discussions with the battalion commander, you feel that the battalion commander just wants to keep this problem under wraps until he changes command in July. At the next training brief, you will have to report that 0% of your company is qualified on any of the assigned weapons systems. You feel that the battalion commander and his staff are more concerned about appearances than they are about taking care of soldiers. In preparation for the next training brief, the battalion S3 has already scheduled your company for a weapons qualification range in order to let the brigade commander know that actions are being taken to fix the problem. You doubt that he will get the ammunition to conduct the range.

Story 2: You are the commander of an Air Defense battery. A sub-standard lieutenant was attached to your company just prior to NTC rotation. This officer had received mediocre OERs and the battalion commander had assigned him to your company in order to "make or break" him. You did not want this individual attached to your company and tried to persuade the battalion commander to change his mind, but he refused. At the Victory Focus training exercise, the lieutenant in question failed his second ARTEP on his assigned field problem, but disclaimed responsibility for the failure. You again went to your commander and asked that the LT be relieved and told him that you were concerned for the LT's soldiers. Your battalion commander refused to relieve the LT. After Victory Focus, two E-4s from the LT's platoon came to you to complain that their LT was "worthless" and that the soldiers in his platoon were afraid to go to the NTC with him. You reported this to the battalion commander. He brought in the Inspector General who ruled that there was not enough basis to relieve the LT. At the NTC, the LT screwed up from the start. After seven days, the LT accomplished no missions. He completely failed to support a Field Artillery battery to which he had been assigned. Twenty-four hours later when you showed up to inspect the air defenses, the

LT's platoon was nowhere to be found and had not made contact with the artillery unit they were supposed to support. In addition, the LT's platoon was involved in several vehicle accidents and his own vehicle was involved in an accident.

Story 3: On your final NTC rotation as a company commander, your company was cross-attached to a mechanized infantry battalion to form a task force. You had been given a new platoon upon arrival at NTC--a platoon you had reason to believe was ill-prepared to fight. You were advised by your first sergeant to send the new platoon over to an infantry company so that they would not hamper performance of your company during a crucial NTC rotation. Against this advice, you sent one of your best tank platoons over to the infantry company. Your reasons were: (a) that you would not like to be sent an ill-prepared platoon, and (b) that if there was trouble you felt best prepared to deal with it yourself. Subsequently, you learned that your own tank platoon had performed well in the infantry company. Your own company performed well in their NTC, after some initial difficulty. (Corresponds to C2 of the TKML.)

Story 4: You took over command of your company at the same time the company received a new 1SG, two PLT LDRs, two PSGs, and a Supply SGT. You felt that the soldiers in the Company had a bad attitude towards training. So, a few weeks after taking command, you deployed the unit to the field for 21 day FTX. You gave the PLT LDRs the first four days to conduct their own training. On the second day, you inspected stand-to procedures and found that they were poorly performed. You personally inspected each fighting position and ranger card. You called a company meeting and told the company how poor their performance was on stand-to procedures. During this meeting you had the PLT LDRs stand-off to the side of the formation and asked soldiers why their performance was so bad. You made sure that all soldiers had an opportunity to speak. You also used that meeting to communicate your expectations for stand-to procedures. (Corresponds to C1 of the TKML.)